

DUTCH ELM DISEASE

A REPORT TO THE PRESIDENT AND THE CONGRESS OF THE UNITED STATES

**PREPARED IN ACCORDANCE WITH
SEC. 20 OF THE NATIONAL FOREST MANAGEMENT ACT OF 1976
PUBLIC LAW 94-588**

**SUBMITTED BY
THE OFFICE OF THE SECRETARY
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**AGRICULTURAL RESEARCH SERVICE
COOPERATIVE STATE RESEARCH SERVICE**

**EXTENSION SERVICE
FOREST SERVICE**

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H. Cannon, William N., Jr., and David P. Worley. 1976. Dutch elm disease control: performance and costs. Northeast. For. Exp. Stn. USDA For. Serv. Res. Pap. NE-345, 7 p.	

DUTCH ELM DISEASE: A Report to the President and Congress of the United States Prepared in Accordance with Section 20 of the National Forest Management Act of 1976.

SUMMARY

Section 20 of the "National Forest Management Act of 1976" directed the Secretary of Agriculture to conduct a study of Dutch elm disease and prepare a report that (1) provides information on the incidence of the disease, (2) evaluates present methods of control, (3) describes plans for further research to control the disease, and (4) presents an action plan which includes a program of outreach and public information about Dutch elm disease, and recommendations for controlling the spread of the disease. Additional information was requested by Congressmen Fraser and Nolan and is included.

The Forest Service was assigned responsibility for preparing the report in cooperation with the Agricultural Research Service, Cooperative State Research Service, and Extension Service.

Dutch elm disease (DED) is a vascular wilt that was introduced into the United States in 1930 from Europe. DED is caused by a fungus, Ceratocystis ulmi (Buisman) C. Moreau, which is transmitted by two bark beetles: the smaller European elm bark beetle, Scolytus multistriatus (Marsham); and the native elm bark beetle, Hylurgopinus rufipes (Eichhoff). The European species is the principal vector (carrier) in most of the United States. Spread from diseased to healthy elms also occurs through root grafts.

The disease has been reported in all States except Florida, Louisiana, New Mexico, Arizona, Utah, Nevada, Washington, Hawaii, and Alaska. Incidence is highest in the Northeast where in 12 States over 75 percent of the elms in municipalities have been lost. There were an estimated 77 million elms in incorporated areas just prior to 1930. By 1976, an estimated 34 million remained, a reduction of 56 percent.

The causal fungus, its insect vectors, and methods of control are being investigated by Federal, State, and university organizations. In FY 1976 total Federal expenditures for DED research were \$1,319,818. Comparable expenditures are expected in FY 1977. Proposed FY 1978 Federal funding for research is \$1,369,400.

Ongoing research is concerned with the development of: (1) Systemic fungicides for control of the fungus; (2) chemicals for the control of insect vectors; (3) elms resistant to DED and/or beetle vectors; (4) biological control of the fungus; (5) biological control of the insect vectors; (6) techniques to assess the variability of the causal fungus on effectiveness of control

techniques; and (7) improved methods of sanitation, tree pruning practices, and reduction of root graft transmission of the fungus. No single approach can control the disease. Research is designed to provide a variety of tactics and strategies for control that are cost effective, biologically sound, and environmentally safe.

Coordination of research in the Department of Agriculture is achieved by several means. Improved coordination can best be obtained through strengthening of the Agricultural Research Policy Advisory Committee (ARPAC). ARPAC provides the bases for State and Federal cooperation in planning and implementing regional and interstate research programs. Membership on ARPAC includes the administrators of agricultural and forestry research in the universities as well as the Administrators of the agencies in the Department concerned with Dutch elm disease. The Extension Committee on organization and Policy (ECOP) coordinates national extension programs.

Presently used control methods ranked from the least effective (producing virtually no control) to the most effective (loss of 1-5 percent of elm population/year) are: (1) Removal of diseased trees from 1-3 years after death, (2) removal of dead trees before the next growing season, (3) sanitation and removal of dead and dying elms within 30 days of detection, (4) sanitation plus insecticidal spray programs to protect healthy elms, and (5) sanitation, spraying with insecticide, and treatment of root grafts. Variation in the success of the more effective methods is caused by (1) failure of authorities to comprehend the gravity and urgency for survey and control when DED is first discovered, (2) lack of concern for a small population of elms resulting from low initial numbers or from mortality due to DED, (3) lack of funds, and (4) failure to persistently apply the most effective control methods.

A control program is most beneficial if implemented when the disease is first detected. To be effective, the program must be designed to reduce the annual rate of mortality to 5 percent or less of the remaining elm population. The recommended control programs must encompass all susceptible elms, public and private alike, and include: (1) Extensive aerial and complete ground surveys during the summer to detect diseased elms; (2) prompt removal and destruction of all diseased and dead elms to prevent bark beetle population buildup; (3) spraying the entire elm population in the spring using methoxychlor; and (4) treatment or severance of root grafts between diseased and healthy elms.

The Department of Agriculture Organic Act of 1944 (58 Stat. 735, as amended; 7 U.S.C. 147a) authorizes the Secretary to carry out operations or measures to detect, eradicate, suppress, control or to prevent or retard the spread of plant pests, including DED. The Secretary may enter into cooperative agreements to carry out the provisions of this section. The Department has had no active

DED survey and control program since the quarantine to prevent domestic spread was rescinded on April 1, 1947, and the quarantine to prevent foreign importation was rescinded on April 15, 1966. The quarantines were rescinded following assessments that the natural spread of the DED could not be practically prevented.

Municipal control programs, costing an estimated \$30 million annually, now protect approximately 1.8 million elms out of an estimated 24.4 million elms that might be protected with additional resources. The benefits of control were recently demonstrated when a 15-year examination of annual expenditures by 39 communities with DED-infected elms showed that control programs cost from 37 to 76 percent less than the cost of removing DED-killed elms where no control was attempted.

In considering Federal participation in municipal DED control programs, the principal alternatives are (1) technical assistance and extension education, (2) technical assistance and extension education plus revenue sharing to finance control activities, and (3) technical assistance and extension education plus cost-sharing of control activities. Technical assistance and extension education would encourage additional municipalities to protect their elms, resulting in the protection of up to 1.9 million elms at a total annual cost of \$36.8 million dollars. Revenue sharing funds may be used to finance DED control or to match Federal cost-sharing funds. Federal cost-sharing alternatives range from 25 to 50 percent Federal share. Technical assistance, extension education, and 25 percent Federal share would help protect an estimated 7.6 million elms at a total annual cost of \$133.1 million while technical assistance and 50 percent Federal share would protect an estimated 13.2 million elms at a total cost of \$229.4 million annually. It must be emphasized, however, that local commitment, which can be achieved through local funding, is critical to the success of a program.

The plan developed for outreach and public information on DED is intended to inform small communities, municipalities, landowners, and the public of the history, incidence, and severity of DED, and to inform them of the importance of controlling the disease with the latest control methods. The plan would be implemented through existing information organizations in the Department of Agriculture. Total costs are estimated at \$2,555,000 over a 5-year period.

The general objective of the range of alternatives for Federal participation in a national program is to reduce the loss of elms so as to provide time for newly planted non-susceptible species to grow and for research to investigate alternative strategies for direct and indirect DED control. We must recognize, however, that although current control techniques may reduce annual elm losses to as low as 1 percent, the continued loss of elms to DED is a certainty.

INTRODUCTION ^{1/}

Section 20 of the "National Forest Management Act of 1976" (Public Law 94-588) directed the Secretary of Agriculture to conduct a study of Dutch elm disease (DED) and prepare a report as follows:

"The Secretary of Agriculture, in consultation with officials of both the States and political subdivisions thereof, shall conduct a study of the incidence of Dutch elm disease and evaluate methods for controlling spread of such disease. The Secretary shall prepare and submit to the President and both Houses of Congress on or before March 1, 1977, a report which includes--

- (1) results of such a study;
- (2) plans for further research into the control of Dutch elm disease; and
- (3) an action plan which includes a program of outreach and public information about the disease, and recommendations for controlling the spread of the disease."

In addition to the information required by the Act, Congressmen Donald M. Fraser and Richard M. Nolan requested that the following be included in the report:

- a. Comparative cost analysis of early vs. later control programs in selected States and localities.
- b. Estimated expenditures for control and/or sanitation.
- c. Alternative State-Federal funding arrangements with cost/benefit analysis for each alternative.
- d. Bibliography of publications on DED.
- e. Evaluation of alternative arrangements for coordinating research and bibliographic efforts.

In compliance with Section 20 of the National Forest Management Act of 1976, and requests, the following report on DED was prepared.

^{1/} Mention of a proprietary product in this report is for reader's information only and does not constitute endorsement by USDA to the exclusion of other similar products.

PROCEDURES

The Secretary of Agriculture designated the Forest Service to coordinate this study and prepare a report obtaining information from the Agricultural Research Service, Cooperative State Research Service and the Extension Service.

Each agency was requested to provide answers to the following questions regarding DED control and research:

- (1) What is your appraisal of existing DED control strategy?
- (2) What is your ongoing research including plans for FY 78?
- (3) What additional research is needed to significantly improve DED control capabilities?

In addition to the above agencies in the USDA, information was requested from the States and political subdivisions listed in Appendix A.

The State agencies were asked to:

- (1) List counties with DED.
- (2) Estimate the number of elms within municipalities of the State prior to the detection of DED and as of 1976.
- (3) Estimate current annual Statewide expenditures for DED control.
- (4) Evaluate the major obstacles to an effective disease control program.
- (5) Suggest effective methods for an outreach program to inform arborists, city governments, and the general public about DED and its control.

These data and the responses were compiled and analyzed for inclusion in this report. Each of the above USDA agencies, and the Animal and Plant Health Inspection Service reviewed this report.

HISTORY AND DESCRIPTION OF DUTCH ELM DISEASE

Dutch elm disease (DED) is the most destructive shade-tree disease in North America. DED which was first discovered in the United States in Ohio in 1930, was introduced on elm veneer logs imported from Europe. The fungus causing the disease infects all native elm species and some introduced species. Unfortunately, the American elm (Ulmus american L.) is the most susceptible species.

The disease, classed as a vascular wilt, is characterized by a gradual wilting and yellowing of the foliage, usually followed by defoliation and death of affected branches, and finally by death of the whole tree. Less frequently the entire crown may express symptoms almost at once. This process can take 1-3 years, but usually affected trees die within a year, and often only a few weeks after symptoms first appear. Not all elms react the same to the causal fungus and there is some variation in fungal virulence (capacity to cause disease) resulting in varying degrees of symptom development and rate of dying.

The actual wilt is caused by the blockage of the sap stream resulting from the action of a pathogenic fungus, Ceratocystis ulmi (Buisman) C. Moreau, which is introduced into the sap stream of twigs or small branches during feeding by two species of bark beetles. These insects: the smaller European elm bark beetle, Scolytus multistriatus (Marsham), and the native elm bark beetle, Hylurgopinus rufipes (Eichhoff), fly from their breeding sites in logs containing the fungus and transmit the fungus into the twigs as they feed. The European species is the principal vector (carrier) in most of the United States; its life cycle is shown in Figure 1. Throughout this report the term "elm bark beetle" or "bark beetle" refers to the European elm bark beetle.

The disease and resultant death of elm trees are thus brought about by a complex interaction of fungus, insect vector, and host tree. This interaction is influenced by fungus variability, elm species, elm bark beetle population, distance between trees, and climate. In addition, once the disease is established in a municipality or elm grove, its spread is enhanced by fungal growth through root grafts between diseased and healthy trees.

The disease kills very few elms the first 2 to 4 years after becoming established in a community. However, as the elm bark beetle population and inoculum (fungus) builds up, the mortality rate (without controls) may reach 10 percent or more of the remaining elm population per year. It is not uncommon for 50 percent or more of the elm population in an area to be killed over a 10 year period.

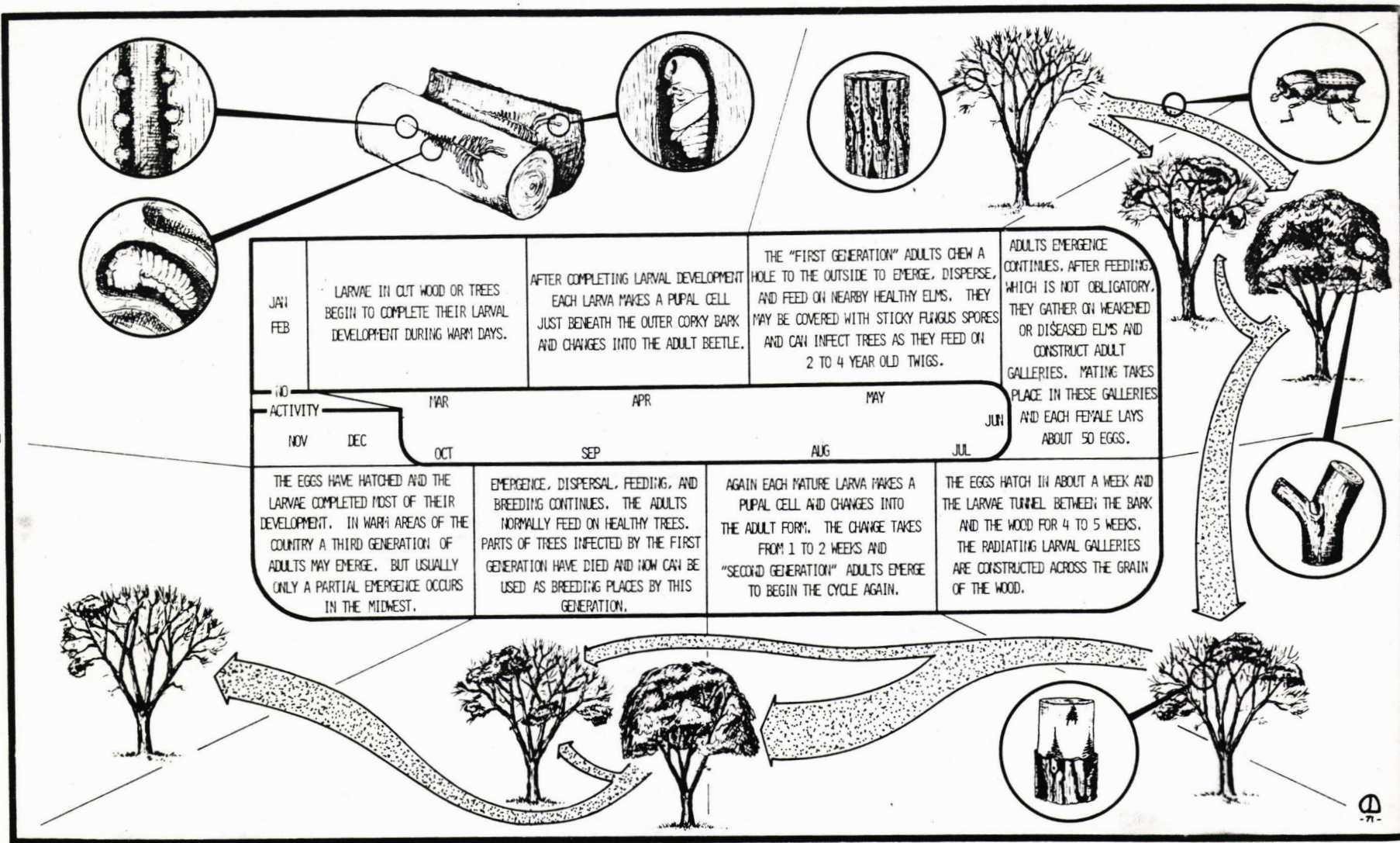


FIGURE 1. The life cycle of the smaller European elm bark beetle. Variations in timing may occur in different geographic locations.

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DISTRIBUTION AND INCIDENCE OF DUTCH ELM DISEASE

Since 1930, Dutch elm disease (DED) has spread to 41 States from coast to coast. The only States not reporting the disease are Florida, Louisiana, New Mexico, Arizona, Utah, Nevada, Washington, Hawaii, and Alaska. Twenty-three States (mostly in the Northeast and Midwest) have DED in every county (fig. 2).

The incidence of DED, measured in percent of trees lost, is highest in the Northeastern States and lowest in the Southern and Western States. Twelve States, all in the Northeast, have lost over 75 percent of the elms in municipalities. Of the 16 affected States west of the Mississippi River, 12 have lost less than 25 percent, and 9 of these have lost less than 5 percent (fig. 3 and 4).

The percent of trees killed is closely related to the length of time DED has been present in a State (table 1). In the States where DED was discovered during the past 10 years, an average of 95 percent of the elms remain. Where DED was reported 21 to 30 years ago, an average of 32 percent remain. These are Statewide figures rather than for individual incorporated areas.

Table 1.--Relationship between years since discovery of Dutch elm disease and remaining elms

<u>Years since DED discovery</u>	<u>States</u>	<u>Average elms remaining</u>
	<u>number</u>	<u>percent</u>
1-10	11	95
11-20	9	68
21-30	7	32
31-47	14	23

There were an estimated 77,000,000 elms in incorporated areas of all States just prior to introduction of the disease into the United States in 1930. By 1976, however, an estimated 34,000,000 remained, a reduction of 56 percent (fig. 3).

FIGURE 2

DISTRIBUTION OF DUTCH ELM DISEASE
IN THE UNITED STATES, 1976

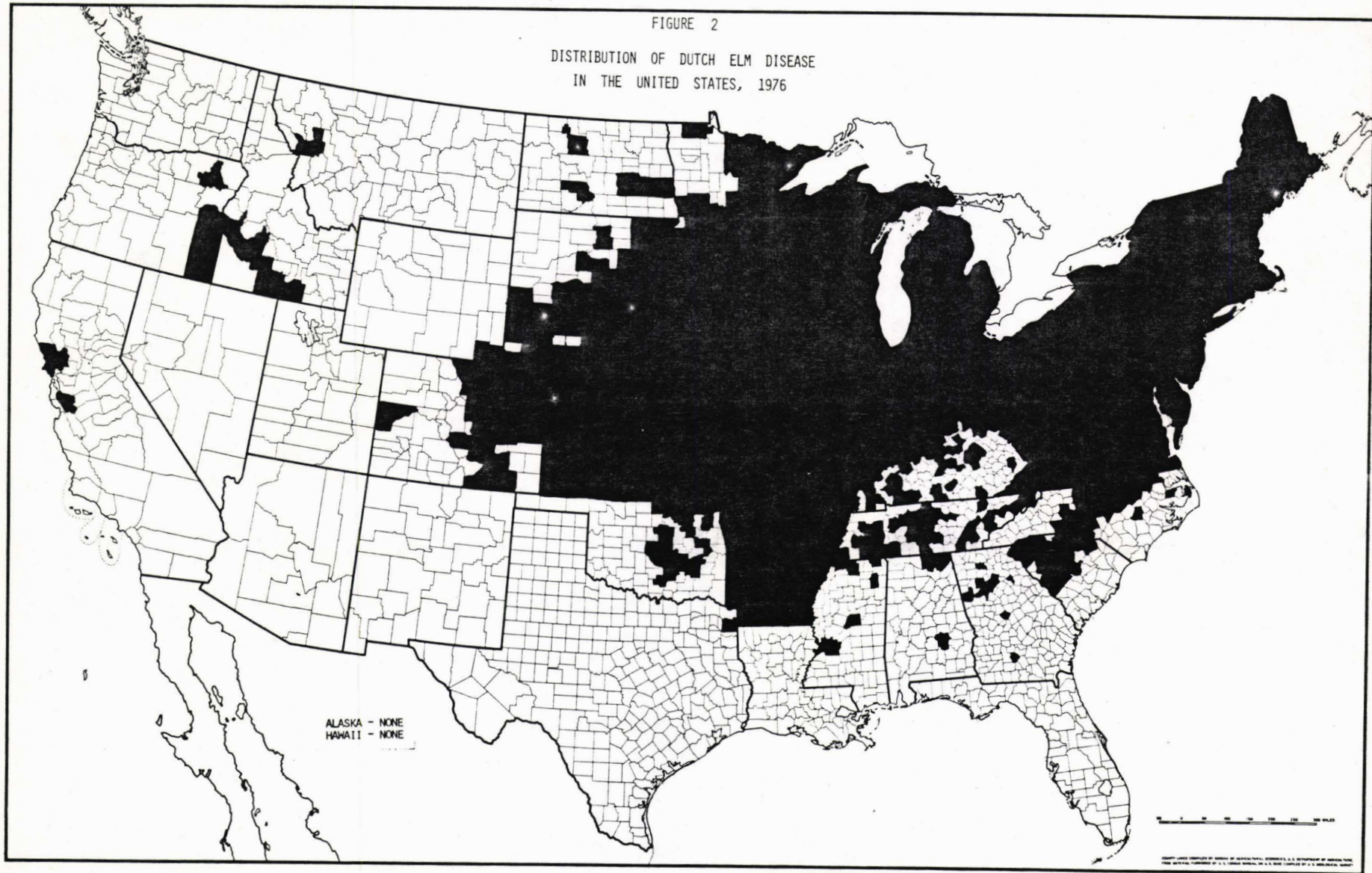


FIGURE 3
DETECTION AND INCIDENCE OF DUTCH
ELM DISEASE IN THE UNITED STATES - 1976

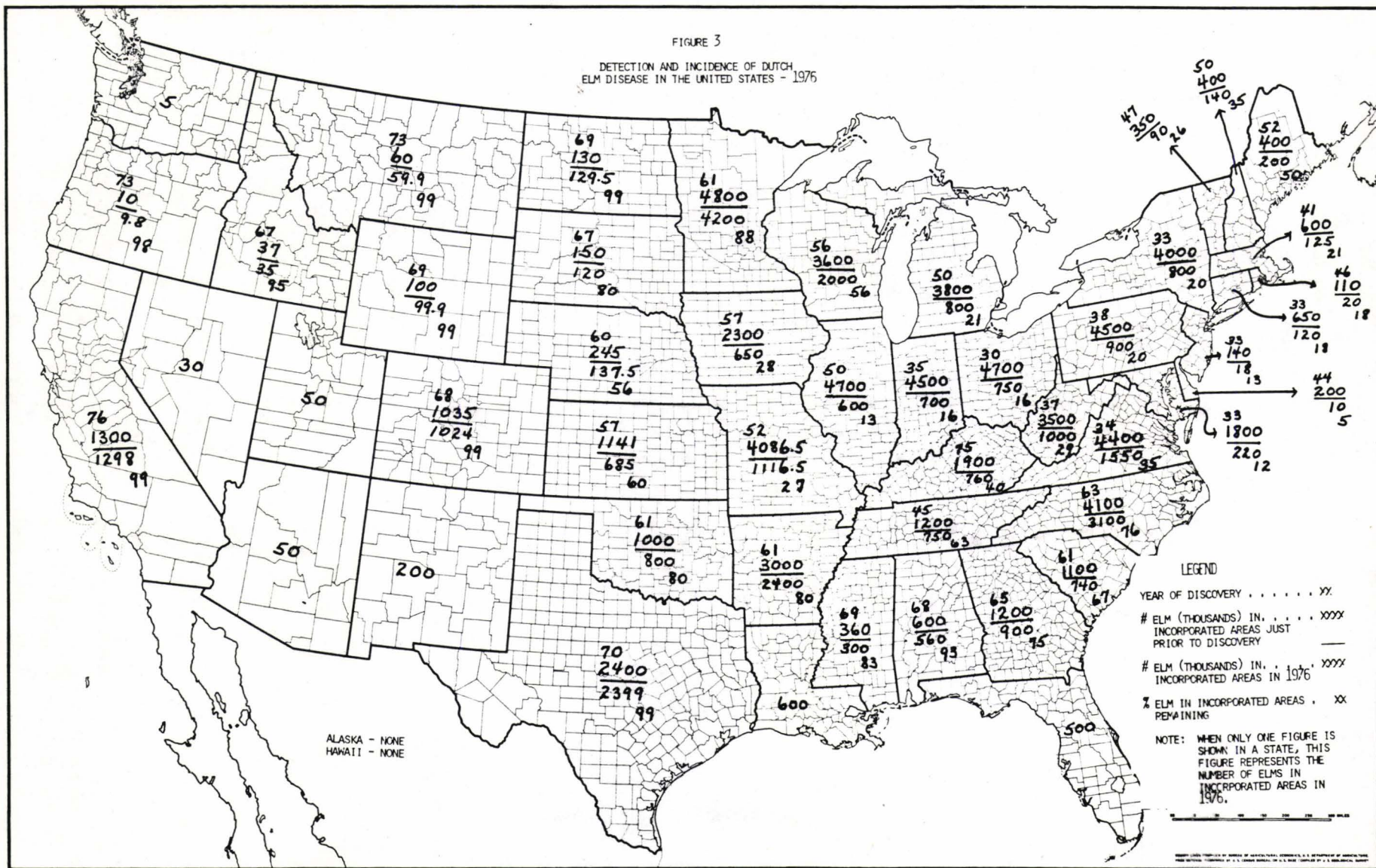
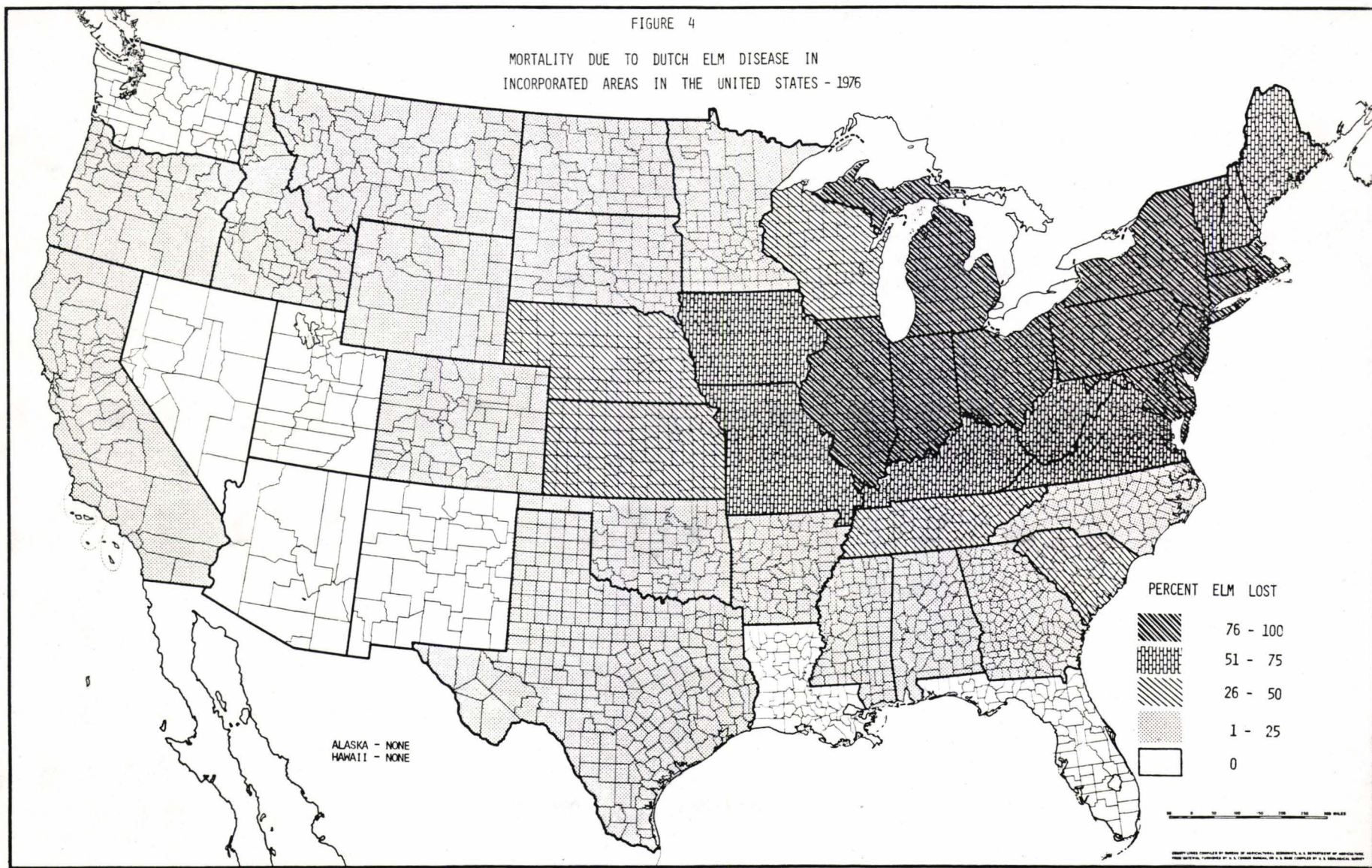


FIGURE 4

MORTALITY DUE TO DUTCH ELM DISEASE IN
INCORPORATED AREAS IN THE UNITED STATES - 1976



RESEARCH ON DUTCH ELM DISEASE

Dutch elm disease (DED) has been studied in Europe for over 75 years. In the United States, the causal organism, its insect vectors, and disease control have been investigated by Federal, State, and university organizations since 1930. The status of current research, additional research needs, and coordination of research and technical information is summarized in the following section.

Current Research Programs

The appropriations and manpower for DED research in the USDA are summarized in table 2 by agency and fiscal year.

Table 2.--Funding and scientist years for DED research

USDA Agency	FY 75		FY 76		FY 77 ^{1/}		FY 78 ^{2/}	
	\$	SY ^{3/}	\$	SY	\$	SY	\$	SY
ARS	319,500	4.6	452,818	4.8	392,200	5.2	405,400	5.2
CSRS	278,000	5.1	282,000	5.3	304,000	5.7	334,000 ^{4/}	6.3
FS	<u>546,000</u>	<u>7.0</u>	<u>585,000</u>	<u>7.0</u>	<u>622,000</u>	<u>8.7</u>	<u>630,000</u>	<u>8.5</u>
TOTAL	1,143,500	16.7	1,319,818	17.1	1,318,200	19.6	1,369,400	20.0

^{1/}Estimated

^{2/}Represents proposed appropriation

^{3/}Scientist year

^{4/}Based on anticipated fund increase of 10 percent over 1977 level

A list of research projects and studies on DED supported by Federal funds is provided in Appendix B. In addition to research conducted at Federal laboratories by the Agricultural Research Service (ARS) and the Forest Service (FS), the Cooperative State Research Service (CSRS) funds research at 11 universities; the Forest Service, through cooperative aid agreements, funds research at 2 others.

Current research can be grouped into seven general categories:

1. Evaluation of Lignasan BLP (methyl 2-benzimidazole carbamate phosphate) and new systemic fungicides for control of the pathogen.
2. Research on insecticides, pheromones (sex attractants), and other behavioral compounds (feeding stimulants and deterrents) for chemical control of the insect vectors.
3. Development of elm varieties resistant to DED and/or the bark beetle vector.
4. Studies of avirulent (non-pathogenic) strains of the fungus and antagonistic microorganisms for biological control of the pathogen.
5. Investigation of parasites and predators for biological control of the insect vectors.
6. Determination of the variability of the pathogen (fungus) and the effects of this variability on disease incidence and severity, and tolerance to fungicides.
7. Studies of improved sanitation and tree pruning practices, and reduction of root graft transmission.

The objective of the research is to provide cost effective, biologically sound, and environmentally safe strategies for controlling DED. The research described below will yield additional technology for improved control strategies within the next 5 years.

Systemic fungicides injected into diseased elms to arrest development of fungus and "save" the trees have shown great potential as a control procedure. A technique using high pressure injection and the promising systemic fungicide, Lignasan, is now undergoing additional field tests. Experimental success with this technique has been variable and limited to trees with symptoms on less than 30 percent of the branches. Further development and refinement of this control technique is necessary before it can become a standard operational procedure. It should also be noted that the DED pathogen has shown a high degree of tolerance to Lignasan in laboratory studies so currently research is investigating: (1) How this tolerance develops in the fungus, (2) the stability of the tolerance, (3) the impact on disease control with Lignasan when elm trees are inoculated with tolerant fungus strains, and (4) the development of new water soluble fungicides and improved formulations and injection techniques.

A naturally occurring fungitoxicant, decanoic acid, has been found in the seeds of American elm. Studies are also in progress to isolate and identify fungitoxicants from the leaves of resistant,

juvenile American elms. Chemicals of this type promise to be less toxic to elm trees and less injurious to the environment than present synthetic fungicides, but their practical importance has not been demonstrated.

Chemical control of the bark beetle vectors can be accomplished by spraying an insecticide, such as methoxychlor^{2/}, on the feeding and breeding sites. This reduces the transmission of the disease and lowers population levels of the beetles. Improved insecticides, insecticide formulations, and application techniques are results anticipated from continuing research. The research could develop suitable replacements for methoxychlor and more economical and efficient methods for achieving complete insecticidal coverage of treated elms.

Pheromones and other natural or synthetic compounds, which affect the behavior of the insect vector, may be useful additions to control by pesticides. These chemicals may be used either singly or in combination with insecticides to achieve optimum control of the insect vectors. The pheromone of the European elm bark beetle has been identified, and a synthetic mixture, "Multilure," shows promise as a chemical for beetle control. A practical system for beetle surveillance with synthetic attractant pheromones is being developed. This technique would allow users to determine beetle emergence periods, beetle population levels, and the presence of spore-carrying beetles in areas of low beetle or disease incidence. Programs to control the beetles and thereby the disease would be timed and applied accordingly. Pheromone trapping may also have practical application for control of beetles, when mass trapping is applied as an adjunct to sanitation and insecticide spray procedures.

Disease resistant varieties are an established approach for control of tree diseases. Some species of elm are more resistant to DED than others and crossing and breeding programs have resulted in the development of several resistant varieties. One hybrid, the "Urban Elm" will be released in the near future. Also, a disease-resistant selection of American elm is in final stages of testing and will be released to the nursery trade when sufficient stock is available. Additional clones of resistant elms are under study. A selection program also has been initiated to find American elms that are resistant to elm bark beetle feeding. Beetle-resistant trees could be as effective in a control program as are varieties that are resistant to the fungus. Disease- and beetle-resistant varieties must have desirable form and be able to survive the often severe urban environment if they are to be acceptable.

^{2/}Schreiber, L. R., and J. W. Peacock. 1974. Dutch elm disease and its control. USDA Forest Service and Agricultural Research Service. Agric. Info. Bull. 193, 16 p. (See Appendix G.)

It is anticipated that one or more new disease- and/or beetle-resistant elm varieties or hybrids will be released during the next 5 years. These resistant elms will retain many of the desirable characteristics of rapid growth, pleasing form, and tolerance to urban environments that make elm the premier urban street tree. Such resistant elms could provide new possibilities for the replacement of elms killed by DED as well as for planting in newly-developed residential areas. By lowering the density of susceptible trees in a community, resistant elms would indirectly affect the control of DED by reducing the populations of susceptible elms.

Studies of improved methods of elm propagation are part of the tree breeding program. Resistant varieties or species vary greatly with regard to vegetative propagation. However, techniques have been developed that have increased the efficiency of propagation by both grafting and rooting of cuttings. These improved techniques should expedite providing resistant trees to the nursery industry.

Biological control of the pathogen is a relatively new approach to the control of DED and the potential is yet to be demonstrated. Investigations are being undertaken to determine the possible effectiveness of avirulent (nonpathogenic) strains of the pathogen in competing with virulent strains in the host tree. Evidence also exists that less aggressive strains of the fungus may be infected by viruses. Research is in progress to determine whether viruses can be used to biologically control the fungus. Antagonistic bacteria are also being investigated for their ability to reduce disease severity in infected elms. Bacterial antagonists have been isolated and are now being introduced into elms to determine if they will (1) multiply in the host, and (2) reduce disease severity in infected elms.

Biological control with parasites and predators have the potential to reduce populations of bark beetle vectors and thereby serve as an adjunct to other control methods. Research is being conducted to identify the most promising parasites and predators (native and European) and to determine their effectiveness in reducing beetle populations.

Variability of the causal fungus could disrupt long-term control strategies. Recently, an apparently new strain of the fungus was discovered in Europe. Studies have shown that this strain is highly virulent in elms previously judged to be resistant to DED. The presence of such virulent strains in the United States could have profound effects on the development of resistant varieties of elm. Also, some strains of the fungus are tolerant to the fungicide, Lignasan. Such tolerance could reduce the effectiveness of DED control by systemic fungicides.

Sanitation, the removal of all or parts of diseased trees is the cornerstone of DED control. Sanitation contributes to the reduction in the amount of fungus available for transmission as well as a reduction in breeding sites. Research is being devoted to improving present practices of detection so that sanitation can be carried out promptly. Work is also underway to develop methods for reducing bark beetle breeding when diseased trees and wood cannot be removed promptly. There is also research into the use of deep girdles around the trunk of infected trees to prevent fungus movement into and through grafted root systems.

In addition to current research programs, some new research studies could be initiated. The additional resources have not been estimated at this time. Areas for consideration are: (1) Techniques for evaluation of DED control strategies, including the development of systems for modeling, beetle population sampling, and population dynamics; (2) studies of the physiology of fungus parasitism to determine how water supply is disrupted in diseased trees, how resistant and susceptible trees differ in their anatomy and chemical responses to infection, and how resistance is expressed in trees; (3) studies to isolate and identify the attractant pheromones and other behavior-modifying chemicals of the native elm bark beetles; (4) studies in biological control of DED, particularly using less aggressive isolates of the fungus; (5) determination of naturally occurring substances which inhibit the growth of fungus in resistant elms and particularly in all seedling elms which are presently universally resistant; and (6) studies on the relationship of DED to elm phloem necrosis which may be as detrimental to elms as DED.

It is unlikely that DED can be controlled by a single approach. A variety of tactics and strategies are needed that, when combined into integrated control practices, can effectively reduce the impacts of DED on urban environments. The program of research in the U.S. Department of Agriculture is aimed at providing the technology essential to improve control of DED.

Coordinating Research

Research conducted by the U.S. Department of Agriculture (USDA) with appropriated funds is centered in three agencies--Agricultural Research Service (ARS); Cooperative State Research Service (CSRS); and Forest Service (FS). As requested by Congressmen Fraser and Nolan, the coordination of Dutch elm disease (DED) research in the USDA is discussed below.

Research on DED conducted or funded by the USDA could be coordinated in several ways. For example, one agency could be designated as the lead agency responsible for overall coordination; all research on DED could be assigned to one agency; or, current mechanisms for coordination could be strengthened.

The ARS and FS conduct research on DED in Federal laboratories and also fund research at universities in support of their program missions. The CSRS administers Federal funds for agricultural and forestry research conducted by State universities. Each of the agencies serves a somewhat different constituency. The varying but complementary approaches to resolution of the DED problem foster scientific inquiry and technological advances.

Within the scientific community, awareness of current DED research is maintained by a number of means. In addition to personal communications, scientists concerned with DED participate frequently in regional, national, and international meetings at which research findings are presented and discussed.

The USDA Current Research Information System (CRIS) also provides means whereby scientists and administrators are informed on DED research. Through CRIS, pertinent information concerning individual projects on DED can be rapidly retrieved. The information in CRIS is updated yearly to provide information on the scope of the research and the advances attained.

Most university and USDA research on DED is encompassed by two regional projects:

1. NE-99. Biology and Control of Vascular Diseases of Plants. Participation includes six universities in the Northeast, and the ARS and FS facilities at Delaware, Ohio. In addition, three universities in the Northcentral region and one Western institution (University of California) participate.

2. NCR-32. Vascular Wilts of Forest and Shade Trees. Participation includes seven universities in the Northcentral region, ARS and FS at Delaware, Ohio, and the University of Nebraska. A number of additional State and public cooperators also participate in this program.

The establishment of the Agricultural Research Policy Advisory Committee (ARPAC) by Secretary's Memorandum No. 1657 has greatly strengthened research planning and coordination in the scientific community. Membership includes administrators of agricultural and forestry research in the universities and the Administrators of several agencies in USDA including the Agricultural Research Service, Cooperative State Research Service, Extension Service, and Forest Service.

An objective of ARPAC is to "...develop further the bases for State and Federal cooperation in planning and implementing regional and interstate research programs..." This objective is effected through the formation of either standing subcommittees or ad hoc groups for particular tasks. A joint State-Federal leadership that characterizes ARPAC functions is a strong stimulus to realistic and active cooperation in all aspects of research including research on DED. The Regional and National Agricultural Research Planning System established by ARPAC in 1971 also strengthens research planning and coordination regionally and nationally.

Through ARPAC and the two regional projects on DED, ways are available for planning and coordinating research on this disease. These mechanisms are in place. They are proving to be effective in directing the course of research on DED.

Technical Information Retrieval

Over 75 years of concern for the Dutch elm disease (DED) and research on its causal organism, insect vectors, and control are embodied in more than 1,900 published articles and uncounted numbers of unpublished reports. Reports of general observations and research results have appeared in a broad range of outlets including scientific journals in English and several other languages, Federal and State Experiment Station publications, trade journals for arborists and pest management specialists, Cooperative Extension Service publications, popular magazine articles, and newspaper articles. A full knowledge of a significant portion of this literature is of great importance to avoid unnecessary duplication of research and maximum application of technology for control of DED.

Access to the current literature on DED is not difficult. The most significant literature has been published within the past 5-10 years and can be readily recovered. The plethora of scientific journals, abstracting journals, and the popular media are well represented in agency and university libraries. Agencies and many research scientists have lengthy distribution lists for reprints of separate articles; copying services are readily available to all. Access to the historical information (publications more than 20 years old) may be more difficult. However, major bibliographic works, e.g., Laut and Schomaker (Appendix F) give lists of citations with broad coverage.

Modern technology provides opportunities for more efficient ways of retrieving and presenting broad data bases such as for DED. An ideal technical information system would deliver in a relatively short time (days) complete and accurate citations of published literature with abstracts of the more important documents. Such a system would be highly useful to research scientists and control specialists.

Although technical information systems are available from commercial sources, the information supplied often needs to be supplemented to be fully useful. The Forest Service is developing a resource-oriented system, Renewable Resources Technical Information System (RRTIS), especially suited to the need. Current publications from Forest Service research scientists become entries in RRTIS. Except for a trial run to demonstrate the potential of the system, no concerted effort has been made to incorporate the full data base on DED in RRTIS.

A modest investment (relative to past and current costs of research and control on DED and property values) is needed to bring the worldwide literature on DED into RRTIS. The system has been designed and guidelines for preparing input and obtaining outputs are available. Resources are needed for a technical specialist (plant pathologist or entomologist), clerical assistance to prepare input to the system and to provide services, and operating funds for processing. Any specific bibliographic effort on DED should be entered into a system such as RRTIS to facilitate exchange of information with similar systems nationwide and worldwide.

SURVEY AND CONTROL PROGRAMS

Evaluation of Current Survey And Control Methods

Survey Methods

The following methods of surveying for DED are presently used in various parts of the country. They are presented in order of the least to the most effective:

- (1) Casual ground observation of all tree species for damage. This is the least effective method of detecting DED since a specific survey is not made and diseased elms are not singled out. About 30 percent of the elms showing DED symptoms are detected using this method.
- (2) A single ground survey for DED each year, conducted during June or July. The best time for detecting DED is soon after the spring flight of elm bark beetles. Using this procedure, about 50 percent of the total DED infected elms are located.
- (3) Three ground surveys each year, usually conducted in June, July, and August. These surveys find the elms which were: (a) infected the previous late fall; (b) infected after the spring beetle flight; and (c) infected after the summer beetle flight, respectively. Approximately 80 percent of the total DED trees are detected with this system.
- (4) Continuous ground surveying from June through September. This results in each tree being surveyed four or more times each year. Greater than 90 percent of all DED trees are detected.

Many States and municipalities in the Northeast follow method #1 or #2 because the majority of the elms have died. (DED has been present in these States about 40 years). Methods #1 and #2 are also primarily used in the Southern States where a large portion of the shade trees are species other than elm. Methods #3 and #4 are used by municipalities in several Western and Midwestern States where elms still constitute a large percentage of the total shade tree population.

Some States, for example, Washington and New Mexico, and municipalities in Minnesota, Oregon, and California, which are near known sources of DED, but have not detected it, conduct surveys for the elm bark beetle. This practice helps to locate probable future DED infection sites.

Control Methods

The following methods of control are now being used.

(1) Sanitation involves the removal and disposal of all dead and dying elm trees, branches, or wood that has the bark intact to eliminate bark beetle breeding sites. Sanitation practices should be performed within a few days of detection. Sanitation is an effective control if it can be thoroughly applied to an entire elm population. The problem is that complete and timely sanitation often is impractical because of the logistical problems of locating and disposing of the diseased trees before beetles emerge.

(2) Sanitation plus a chemical spray. The spray phase involves spraying the entire tree crown with an early spring application of methoxychlor to prevent beetle feeding in healthy elms.

Chemical spraying with methoxychlor is effective if thoroughly applied. Complete coverage of all the branches, however, is seldom achieved. The problems include wind, cold temperature, restricted placement of spray equipment because spring thaws and rains make the sod soft, and location of trees with respect to buildings and other physical obstructions. Another drawback of spraying is that adverse environmental impacts cannot be completely eliminated.

(3) An integrated method which includes sanitation and spraying as in (2), plus chemical or mechanical severance of roots to prevent spread of the fungus through root grafts between diseased and healthy trees.

Severance of root grafts between diseased and healthy trees is effective in preventing underground tree-to-tree spread. These treatments, however, are not applicable in many situations. Paved sidewalks and roadways prevent getting at grafts between street and lawn trees. Use of chemicals or mechanical ditching may kill or damage grass, trees, and shrubs close to the treatment site. By itself, severance of root grafts is also ineffective as a control method because it offers no defense to the main source of spread, e.g., beetle transmission.

Pressure injection of Lignasan BLP for the prevention or cure of fungus infection shows promise and has been used experimentally but needs further development and refinement with regard to dosage rate and application techniques before it can become a standard operational technique. Success with this technique has been variable and limited to trees with symptoms in less than 30 percent of the branches.

In the Northeast and South, most municipalities use only method #1, because of lack of money and the low percentage of elms remaining in the Northeast and the presence of many non-elm shade trees in the South. Many areas of the upper Midwest and West utilize methods #1 and #2.

Control Program^{3/}

Based on current knowledge and technology, a DED control program should include:

1. Continuous ground survey from the end of May through September.
2. Thorough sanitation--the elimination of all infected elm wood before beetles can develop and fly to healthy trees.
3. Protective chemical spray^{4/}--One application of methoxychlor in the spring.
4. Severance of root grafts between infected and adjacent healthy elms.

These control procedures are discussed in detail in the publication "Dutch Elm Disease and Its Control"^{5/}

3/Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers--out of reach of children and pets.

NOTE: Registrations of pesticides are under constant review by the Environmental Protection Agency and the U.S. Department of Agriculture. Use only pesticides that bear a Federal registration number and carry directions for home and garden use.

4/In some parts of the country where the entire elm population is within the city area thus permitting complete sanitation, chemical sprays may not be necessary.

5/Schreiber, L. R. and J. W. Peacock. 1974. Dutch Elm Disease and Its Control. USDA Forest Service and Agricultural Research Service. Agric. Info. Bull. 193, 16 p. (See Appendix H.)

Economic Justification for Dutch Elm Disease Control in Municipalities

The economics of DED impact on municipal resources must be examined in terms of the costs of removing and replacing dead trees, in depreciation of property values because of shade tree loss, and in control program costs. An expense occurs regardless of the action taken by a municipality having DED infected trees.

Cannon and Worley^{6/} examined the 15-year annual expenditures by 39 communities with DED-infected elms. In these communities the costs of control during the 15-year period were 37 to 76 percent less than the cost of removing dead trees where no control was attempted. Recognizing that control costs and program success varied considerably, Cannon and Worley used the annual cost extremes for active control programs to describe the range of costs within which all control programs might be expected to fall.

Cannon and Worley used cost data and performance data to develop a 15-year budget for three alternative courses of action.

1. Tree removal with no control--an estimate of the cost of doing nothing.
2. Tree removal with fair control performance using the highest costs from the cost range. Fair performance is achieved if no more than 5 percent of the elms die each year. This alternative gave an estimate of the highest average costs to be expected from an active control program.
3. Tree removal with the best control performance, using the lowest costs from the cost range. Best performance is achieved if no more than 1 percent of the elms die each year. This alternative gave an estimate of the lowest average costs to be expected from an active control program.

^{6/}Cannon, W.N., Jr., and D.P. Worley. 1976. Dutch elm disease control: performance and costs. USDA Forest Service Research Paper NE-345, 7 p., illus. (See Appendix G.)

The costs for each alternative course of action plus 40 percent for administrative overhead were discounted at 6% and 10% to obtain the present value of the 15-year programs monitored by the Cannon and Worley study (Appendix C). By dividing the present value of no control by the present value of each control alternative the following benefit:cost ratios for municipal control programs were developed:

	Discount Rate	
	6%	10%
Fair Control Performance	1.36:1.0	1.46:1.0
Best Control Performance	2.96:1.0	3.06:1.0

These ratios, therefore, represent the range in economic efficiency for control programs performed at an acceptable level of success compared to the cost of tree removal without control.

The implication of this analysis is that a DED control program which succeeds in maintaining an annual rate of elm mortality at 5 percent or less is economically justifiable. However, since the Cannon and Worley study derived data from a relatively small number of communities in a restricted geographic area the results cannot be used to imply an economic justification for a national DED control program.

FEDERAL PARTICIPATION IN DUTCH ELM DISEASE CONTROL PROGRAMS

Federal Role

The Federal role in dealing with the Dutch elm disease is, under current policy, limited to carrying out research, publishing findings, conducting educational programs, and providing technical advice on control strategies to those who seek it. Efforts to halt the spread of the disease by quarantine were abandoned on the basis that the natural spread could not be practically prevented. Financial assistance for control projects has never been offered.

The procedure employed to identify or define a Federal role for insect and disease control programs under the authority of the Forest Pest Control Act (61 Stat. 177, as amended; 16 U.S.C. 594-1 to 594-5) evaluates the proposed project against a set of criteria which describe circumstances justifying Federal participation. The criteria used for forest insect and disease control programs require demonstration of: (1) international consequences; (2) national and regional economic impacts; (3) need for Federal coordination; (4) threat to Federal lands; (5) threat to unique resources; (6) distribution of benefits; or (7) other Federal role indicators such as a need for special technical expertise. One or more of the following Federal role criteria must be satisfied

before a proposed regulatory program against designated plant pests is established: (1) international implications likely; (2) important segment of agriculture and the general public adversely affected; (3) potential exists for a major agricultural threat; (4) interstate coordination required; or (5) Federal lands and interests threatened.

A national DED control program in municipal areas would represent a significant expansion of the current Federal role concept. The expanded Federal role would rest on the assumption that a significant reduction in the environmental quality of the Nation's towns and cities is being or will be caused by Dutch elm disease.

Too often, the specialized expertise and funds needed to minimize DED-caused tree mortality are lacking. Hence the disease continues to destroy the character and quality of many of the Nation's communities, as well as reducing property values.

Unless a coordinated effort can be mounted and additional funds made available to implement comprehensive protection programs directed at early control, the total number of native elms will continue to decline rapidly.

A federally sponsored program of technical assistance and extension education coupled with active State and municipal cooperation could provide the coordination necessary to develop effective DED control programs. Sources of additional funds would include each level of government from municipal through Federal.

The objective of a DED control program is to reduce the loss of elms to provide time for research to investigate alternative strategies for direct and indirect DED control. The passage of time will also permit the growth of non-susceptible trees and disease resistant elms to shade tree size, reducing community dependence on DED-susceptible elms as a significant shade tree resource.

The degree of protection depends on the performance of the control program. We must recognize, however, that the fate of the municipal elm shade tree resource is not assured by the implementation of a control program. The DED is irrevocably established in most areas where elms are grown. Although current control techniques may reduce annual elm losses to as low as 1 percent, the continued loss of elms to the DED is a certainty.

Statutory Authority

The Department of Agriculture Organic Act of 1944 (58 Stat. 735, as amended; 7 U.S.C. 147a) authorizes the Secretary to carry out operations or measures to detect, eradicate, suppress, control, or to prevent or retard the spread of plant pests, including DED. This authority applies to urban and non-urban areas.

The Forest Pest Control Act (61 Stat. 177, as amended; 16 U.S.C. 594-1 to 594-5) restricts forest insect and disease control activities of the Department of Agriculture to forest lands. These programs are not authorized for urban areas.

The Cooperative Forest Management Act (64 Stat. 473, as amended; 16 U.S.C. 568c, 568d) establishes general authority to encourage the States to provide technical services for management, protection, and improvement of forest lands and the protection, improvement, and establishment of trees and shrubs in urban areas, communities, and open spaces. Payments are not currently provided for technical assistance expenditures for DED control in municipal areas.

The Smith-Lerer Act of 1914 established the Cooperative Extension Service to conduct educational programs. Such programs are mutually agreed to by ES-USDA and the State Cooperative Extension Services.

Alternative Levels of Federal Participation

As requested this report discusses the Federal Government as a source of additional funds for control programs. The report should not be interpreted as advocating that Federal cost-sharing funds be provided.

There are approximately 34,000,000 elms still remaining in incorporated areas throughout the United States. Of these, approximately 1,390,000 are located in States where DED has not been reported and are not considered as immediately threatened (fig. 3).

In considering Federal participation in municipal DED control programs, the four principal areas of involvement are (1) current level, (2) coordinated technical assistance and extension education, (3) revenue sharing, and (4) cost-sharing of control activities (see table 3).

Current Level

This level provides limited technical assistance and extension education in response to specific requests.

Expenditure reports indicate that 23 States are currently spending \$18,726,020 on DED control (Appendix D). Considering that a number of States did not report and others supplied incomplete data, it is estimated that current annual expenditures nationwide are about \$30,000,000. Available data indicate that nationwide control costs average \$17.10 per tree (Appendix C): hence, it is estimated that current control programs are providing some level of protection to approximately 1.754 million elms.

Coordinated Technical Assistance and Extension Education

Any program directed at minimizing losses due to DED will require technical assistance and extension education to encourage municipalities already having control programs to increase the overall effectiveness of their efforts. This program will also advise non-participating communities of the benefits of taking action to prevent spread of the disease and provide them with training and assistance in planning and implementing a DED control program. By improving the control effort in some municipalities and encouraging others to initiate programs, it is estimated that this level will bring the number of trees receiving some protection to 1.929 million.

Eight new Federal and 56 State positions would be required to provide the needed technical assistance. (See Appendix E for geographic breakdown of State positions.) Salary and associated support for these positions would require \$3,360,000 annually in Federal and State funds based on 1977 operating expenses. This figure includes the cost of salaries, travel, office and laboratory facilities, and secretarial support and other administrative costs.

Revenue Sharing

Under current revenue sharing legislation, Federal funds are provided to some 39,000 State and local governments to be used at their discretion. During FY 1978, \$6.855 billion will be allotted under this program. DED control activities could be financed from the Federal funds provided.

A recent amendment to the revenue sharing legislation permits the State and local governments to use dollars allotted under the program as matching funds for other Federal grant-in-aid programs. This could provide the stimulus needed to encourage more municipalities to participate in DED control programs.

Cost-Sharing

If Federal cost-sharing funds were available to offset the local cost of suppression, more suppression would be attempted. Experience in administering the Forest Pest Control Act indicates that the catalytic effect associated with such Federal participation stimulates additional expenditures in the non-Federal sector.

Assumptions

In developing figures for the number of elms to be protected and the associated costs under the several alternatives presented in table 3, the following assumptions were made:

- The number of elms protected under current programs where no Federal funds are involved was determined by dividing estimated annual expenditures by \$17.10, the cost of protecting a tree. Control costs were calculated using \$17.10 per tree protected and the total cost was subsequently determined by adding the cost of technical assistance.
- Additional Federal technical assistance to municipalities would increase the number of elms currently protected by 10 percent, or 175,000 additional trees. This increase is attributed to a modest heightening of public awareness of the need for and benefits of DED control. The 10 percent increase would be in addition to improving the effectiveness of ongoing control programs.
- Eight Federal and 56 non-Federal positions at \$60,000 per position would be required to provide additional technical assistance. The cost per position includes salary, office and laboratory space, clerical support, other administrative costs, and travel expenses. The Federal Government would finance the State positions on a 50-50 matching basis.
- The maximum number of elms protected if the Federal Government assumed all control costs would be 24,458,000, or 75 percent of the 32,610,000 susceptible elms in areas now threatened by DED.
- Numbers of elms to be protected at the indicated levels of cost-sharing were calculated as a proportion of the difference between the maximum number of elms which could be protected if the Federal Government assumed all control costs and the number of elms protected by technical assistance only.

Table 3. Annual costs of DED control under alternative levels of federal participation^{1/}

<u>Alternative</u>	<u>Elms Protected</u> ^{2/}	<u>Total Cost</u> ^{3/}	<u>Federal Cost</u> ^{4/}
	<u>Number</u>	<u>Dollars</u>	<u>Dollars</u>
Current Level	1,754,000	30,000,000	0
Technical assistance and extension education only	1,929,000	36,826,000	2,160,000
Technical assistance and extension education plus 25 percent cost-share	7,561,000	133,133,000	34,483,000
Technical assistance and extension education plus 33 1/3 percent cost-share	9,439,000	165,247,000	55,962,000
Technical assistance and extension education plus 50 percent cost-share	13,193,000	229,440,000	114,960,000

^{1/}All Federal costs shown are in addition to State/municipal expenditures of revenue sharing funds.

^{2/}Determination of the number of elms protected is discussed in the preceding section on Assumptions.

^{3/}Total cost equals cost of technical assistance (\$3,840,000) plus cost of control (\$17.10 per tree protected).

Technical assistance costs include support for 8 Federal and 56 State positions at \$60,000 per position.

^{4/}Federal cost equals Federal share of technical assistance (8 Federal positions plus 50 percent of 56 State positions at \$60,000 per position) plus the Federal share of cost of control.

OUTREACH AND PUBLIC INFORMATION
PLAN ON DUTCH ELM DISEASE

Situation

Cannon and Worley (see Appendix H) reported, "Only those municipalities that conducted a high performance program could be expected to retain 75 percent of their elms for more than 20 to 25 years. Communities that experienced the fewest elm losses had a well founded program, applied it conscientiously and sustained their efforts over the years."

Major obstacles preventing municipalities from conducting high performance programs are the lack of education, technical assistance, and funds. This is verified in the Cannon and Worley report and information provided by several States.

Current Programs

Cooperative Extension personnel, primarily at State and county levels, have been performing some work on the Dutch elm disease problem for many years. This has been done primarily by Extension forestry and horticultural specialists and county Extension agents. As with other problems Extension responds to local requests for information. High priority commitments to production and marketing agriculture have tended to prevent concentrated and prolonged shade tree disease efforts especially by State Extension plant pathologists.

During the last 15 to 20 years most States have had one or more State Extension plant pathologists with a responsibility for working on many plant and crop disease problems. In some States, Extension work on shade tree diseases is combined with general work on shrubs, flowers, and lawn or turf diseases. Duties include diagnosis and clinics in the field, disseminating information, conducting training meetings, and other Extension work. Some States with limited resources have a general Extension plant pathologist with responsibility for all plant, crop, and shade tree diseases. Exact number of Extension person-year equivalents involved with Dutch elm disease is unknown, but is estimated to be approximately 15 to 20 (including county and State Extension personnel primarily).

Services available to communities through State Forestry agencies vary from State to State. The Colorado State Forestry Department, for example, has the primary responsibility for Dutch elm disease

information and education and technical assistance throughout the State. Staff Foresters keep district personnel informed and trained; the district personnel in turn inform and train city personnel. All communities with Dutch elm disease, or adjacent to those communities with Dutch elm disease, are alerted to the problem and have the opportunity to receive training. In Minnesota, services administered by the Division of Forestry to urban areas are limited to distribution of literature and alerts through State and district offices. Many State forestry agencies fit within these two examples.

Through the Illinois and Ohio State Forestry agencies, the Forest Service is cooperating with the cities of Elmhurst, Illinois, and Shaker Heights, Ohio, in Dutch elm disease pilot projects. The projects involve citywide evaluation of a promising systemic fungicide, Lignasan. In addition, the Forest Service, Agricultural Research Service, State Agricultural Experiment Stations and universities provide information on the disease and its control as requested.

Action Plan

Objective

The objective of this plan is to inform communities, municipal governments, landowners, and individual homeowners of the history, incidence, severity, and control of DED, as well as inform them of the importance of controlling the disease. As indicated earlier in this report, DED can be controlled if communities are sufficiently motivated to diligently apply the recommended programs.

Areas of Emphasis

There are three broad geographical areas, each having a different degree of disease activity.

- Area 1: Areas where the disease is already well established and has done considerable damage. This is largely in the Northcentral and Northeastern States. One of two situations exists:
- a. People have ceased to be concerned and need motivation to renew and continue control efforts.
 - b. People are looking for ways to fight against the disease and need technical assistance and guidance to get a program established.

Area 2: Areas where the disease is becoming established.
Example States are Minnesota and Colorado.

Area 3: Areas such as most western States that have had no
DED but need information in order to be watchful and
prepared.

Community requirements for an education and public information
action plan will vary among and within these areas.

With this in mind a flexible Outreach and Public Information Plan
has been developed to support a Dutch elm disease control program
(table 4).

The table displays the outreach activities to be developed. For
each activity the applicable control areas, audience, agency(s)
responsible, and duration are identified. Estimated cost for a 5-
year outreach program is \$2,555,000.

The program is designed to:

1. Motivate people to cooperate in a Dutch elm disease control effort.
2. Stress appropriate local and State organizational structures for educational purposes.
3. Involve local people in planning, conducting, and evaluating educational and control programs.
4. Demonstrate locally adapted Dutch elm disease control practices and educational programs in each of three areas of emphasis via pilot projects. (See areas 1, 2, and 3 as mentioned above).
5. Disseminate results of pilot projects to other States as needed.
6. Provide feedback to appropriate agencies of research needs on Dutch elm disease.
7. Strengthen local and State technical disease diagnostic services through appropriate training.
8. Coordinate Dutch elm disease control efforts with other local shade tree health and pest program efforts.

Table 4. Outreach and Public Information Action Plan

NO.	WHAT	AREAS ^{1/}	TARGET AUDIENCE	WHO	HOW & COSTS ^{2/}	WHEN
1	Continue to update and apprise municipalities on research results and the need for sanitation treatment and on cost and benefit factors.	1&2	National Association of Counties, arborists and horticultural associations, and universities. To be used as outlets for public information.	ARS, CSRS, ES, FS, State Cooperative Extension Services (CES), and other State agencies.	Joint Department Press Releases.(a)	Continuing
2	Provide information on Dutch elm disease and the need for methods of control.	1,2&3	Urban parks and recreation departments, individual homeowners, and absentee landowners.	ARS, CSRS, ES, FS, State CES, and other State agencies.	Prepare and disseminate publications on the disease and its control. These will be tailored to each of the three areas.(b)	Fall, 1978
3	Provide information on the availability of Federal-State cost-sharing programs for control.	1&2	Eligible participants to be identified.	Pending	Pending authorization of a cost-sharing program.	When implemented
4	Provide information about the development and testing of elm varieties resistant to DED and the availability of disease-resistant varieties and species.	1&2	State, county, and municipal governments and homeowners.	ARS, CSRS, ES, FS, State CES, and other State agencies.	Develop pictorial brochure and distribute. National press release on brochure from DC. Field office obtain exposure in weekly and daily papers.(c)	Release as information becomes available
5	Prepare radio and television public spots on DED; its severity, spread, and potential; and sources of technical information and assistance.	2&3	Local city government and homeowners. Release TV materials in selected cities and radio spots in rural areas.	ES, FS, State CES, and other State agencies.	Produce 60-second TV spots with USDA-MPS. Write and produce radio spots through USDA-RADIO-TV Office.(d)	Continuing

NO.	WHAT	AREAS <u>1/</u>	TARGET AUDIENCE	WHO	HOW & COSTS <u>2/</u>	WHEN
6	Inform public on how to identify DED and how to solicit for sanitation and control.	2&3	Municipal parks and recreation departments, homeowners, and large landowners. Also aim for general public.	ARS, CSRS, ES, FS, State CES, and other State agencies.	Produce pre-packaged media materials for coordinated mass media campaign.(e)	Continuing information program
7	Inform ornamental horticultural associations, environmental groups, consulting arborists, and foresters on detection, survey, and control of DED.	3	Members of associations and organizations who already have an interest in horticulture and urban forestry, State, county, and city agencies with parks and recreation programs.	ES, FS, State CES, and other State agencies.	Use associations' quarterly journals, newsletters, etc., as outlets to provide information on the spread of DED.(a)	Continuing basis
8	Conduct pilot education projects.	1,2&3	Community action programs involving citizens and local organizations.	ES, FS, State CES, and other State agencies.	Conduct extension education pilot projects in each of the three areas.(f)	Fall, 1978

1/ See text for explanation of areas.

2/ Estimated total USDA costs on initial (first year) and continuing information outreach projects:

	<u>Initial</u>	<u>5-year Continuing Program</u>
(a) Use of existing agency funds	\$ --	\$ --
(b) Printing, revision, and reprinting	35,000	50,000
(c) Writing, layout, design, and print	35,000	30,000
(d) Write, produce, box, and distribute	40,000	30,000
(e) Write campaign mass media materials, layout, design, and print	75,000	80,000
Administrative overhead (1 man-year)	55,000	300,000
(f) Three extension education pilot projects	325,000	1,500,000
Total	\$565,000	\$1,990,000

Total Outreach Costs - \$2,555,000.

APPENDICES

- APPENDIX A: List of State Agencies Contacted for DED Information
- APPENDIX B: Current Research Funded by USDA
- APPENDIX C: Economic Analysis Calculations
- APPENDIX D: Annual Expenditures of 23 States Reporting for Dutch Elm Disease
- APPENDIX E: Number of New State Positions Needed to Provide Technical Assistance for a National DED Program
- APPENDIX F: Bibliography of Dutch Elm Disease
- APPENDIX G: Schreiber, L. R., and J. W. Peacock. 1974. Dutch elm disease and its control. USDA Forest Service and Agricultural Research Service. Agric. Info. Bull. 193, 16 p.
- APPENDIX H: Cannon, William N., Jr., and David P. Worley. 1976. Dutch elm disease control: performance and costs. Northeast. For. Exp. Stn. USDA For. Serv. Res. Pap. NE-345, 7 p.

Appendix A
List of State Agencies
Contacted for DED Incidence Information

Alabama

Department of Agriculture
and Industry
1445 Federal Drive
Montgomery, AL

Arizona

L. D. McCorkindale
State Entomologist & Director
Arizona Commission of
Agriculture & Horticulture
1624 W. Adams
Phoenix, AZ 85007

Arkansas

Robert Anderson, Director
State Plant Board
421 1/2 W. Capitol Avenue
Little Rock, AR 72203

California

California Department of
Food & Agriculture
1220 U Street
Sacramento, CA 95814

Colorado

John Laut
Staff Forester
Colorado State Forest Service
Colorado State University
CSFS Headquarters Bldg. #360
Foothills Campus
Fort Collins, CO 80523

Connecticut

John Anderson
State Entomologist
Connecticut Agricultural
Experiment Station
123 Huntington Street
New Haven, CT 06511

Delaware

Walter F. Gabel, State Forester
Forestry Section
Delaware Department of
Agriculture
Drawer "D"
Dover, DE 19901

Florida

Division of Forestry
Collins Building
Tallahassee, FL 32304

Georgia

Georgia Cooperative Extension Service
University of Georgia
Athens, GA 30601

Hawaii

Hawaii Department of Agriculture
1428 S. King Street
P.O. Box 5425
Honolulu, HI 96814

Idaho

Director
Idaho Department of Lands
State Capitol Building
Boise, ID 83720

Illinois

Allan S. Mickelson
State Forester
Department of Conservation
605 State Office Building
Springfield, IL 62706

Indiana

John F. Datena, State Forester
Division of Forestry
613 State Office Building
Indianapolis, IN 46204

Iowa

Roy Hatcher
Forest Protection Forester
District 3, State Nursery
Box 823
Ames, IA 50010

Kansas

Dr. William Willis
Extension Plant Pathologist
Department of Plant Pathology
Kansas State University
Dickens Hall
Manhattan, KS 66506

Kentucky

Extension Service
School of Agriculture
Department of Plant Pathology
University of Kentucky
Lexington, KY 40505

Louisiana

Bureau of Entomology
and Plant Industry
Box 44153
Baton Rouge, LA 70804

Maine

John Chadwick
Maine Department of Conservation
Bureau of Forestry
State Office Building
Augusta, ME 04330

Maryland

Robert Altman
Maryland Department
of Agriculture
University of Maryland
College Park, MD 20742

Massachusetts

Stanley Wood, Chief
Bureau of Insect Pest Control
Division of Forests and Parks
Department of Natural Resources
100 Cambridge Street
Boston, MA 02202

Michigan

Daniel Mosher, Entomologist
Michigan Department of Natural Resources
Stevens T. Mason Building
Lansing, MI 48926

Minnesota

James Brooks, Pathologist
Department of Natural Resources
658 Cedar Street
Centennial Office Building
St. Paul, MN 55155

Mississippi

Cooperative Extension Service
Drawer EM
Mississippi State University
Mississippi State, MS 39762

Missouri

Osai B. Capps, State Forester
Missouri Conservation Department
Forestry Division
Jefferson City, MO 65101

Montana

Ray Bjornson
Administrator
Horticulture Division
Department of Agriculture
Helena, MT 59601

Nebraska

Dr. David Wysong
Extension Plant Pathologist
University of Nebraska
305 Plant Industry Bldg.
Lincoln, NE 68503

Nevada

Nevada State Department
of Agriculture
350 Capitol Hill Avenue
P.O. Box 11100
Reno, NV 89510

New Hampshire

Alfred Avery, Chief
Division of Forests and Lands
Department of Resources and
Environmental Development
P.O. Box 896
Concord, NH 03301

New Jersey

William M. Cranstoun, Director
Division of Plant Industry
Department of Agriculture
Box 1888
Trenton, NJ 08625

New Mexico

Donald Lucht
New Mexico Department
of Agriculture
Division of Plant Industry
Box 3189
Las Cruces, NM 88003

New York

E. G. Terrell, Principal Forester
Bureau of Forest Insect
and Disease Control
Department of Environmental
Conservation
Albany, NY 12201

North Carolina

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Appendix B

Current Research Funded by USDA

Research programs supported by the Agricultural Research Service, Cooperative State Research Service, and Forest Service. The appendix was compiled from information provided by the respective agencies.

Agricultural Research Service

Locations:

North Central Region, Nursery Crops Research Laboratory Delaware and Wooster, Ohio. L. R. Schreiber, Acting Research and Locations Leader

Project: Nature and Control of Dutch Elm Disease and Other Shade Tree Diseases

U.S. National Arboretum, Washington, D. C.

F. S. Santamour, Jr., Supervisory Research Geneticist

Project: Breeding and Production--Florist and Nursery Crops

Research Studies:

1. Development, propagation, and evaluation of elm clones resistant to DED--L. R. Schreiber, A. M. Townsend, and F. S. Santamour, Jr.
2. Chemical control of DED--L. R. Schreiber and C. L. Wilson.
3. Biological control of DED--L. R. Schreiber and C. L. Wilson.
4. The nature and role of variability of C. ulmi in disease incidence, severity, and chemical tolerance--A. M. Townsend and C. L. Wilson.
5. The role of water stress on disease development--L. R. Schreiber.
6. Control of root-graft spread of DED--L. R. Schreiber.
7. Tree propagation studies--L. R. Schreiber and A. M. Townsend.

Cooperative State Research Service

Location and Studies

Colorado State University

Project: Dutch Elm Disease--J. W. Brewer.

Studies:

1. Nature of resistance among clones and hybrids of DED resistant elms.
2. Types and levels of parasites and predators of the European elm bark beetle in Colorado.

Connecticut Agricultural Experiment Station

Project: Biological and Chemical Control of DED--J. E. Elliston and S. Rich.

Studies:

1. DED control with systemic chemicals.
2. Induced resistance to DED in American elm with non-virulent mutants of C. ulmi and related fungi.

Cornell University

Project: Biology and Control of Vascular Diseases of Trees--W. A. Sinclair.

Studies:

1. Systemic fungicides for the control of vascular diseases.

Project: Pathology of Wilt Diseases of Trees--W. A. Sinclair.

Studies:

1. Selection and screening of wilt resistant strains of the American elm.

University of Illinois

Project: Etiology, Epidemiology and Control of Vascular Diseases of Trees and Shrubs--D. Neely.

Studies:

1. Control of DED with systemic fungicides.

University of Maine

Project: Pathology of Wilt Diseases of Trees--R. Campana.

Studies:

1. Fungicide injection and pruning for DED therapy.
2. Microbial antagonism to C. ulmi.
3. Influence of host anatomy on pathogen growth, development, movement, and damage.

University of Massachusetts

Project: Pathology of Wilt Diseases of Trees--F. W. Holmes and T. A. Tattar.

Studies:

1. The genetics of pathogenicity and virulence variability in C. ulmi.
2. Propagation and DED resistance testing of elms from thermal neutron irradiated seed.
3. Systemic fungicide for DED therapy.

Michigan State University

Project: Disease Problems of Woody Plants--J. Hart.

Studies:

1. Fungicide sprays for DED control.
2. Propagation and release of elm bark beetle parasites.
3. Selection of DED resistant elms.

University of Minnesota

Project: Control Programs for DED and Oak Wilt--D. W. French.

Studies:

1. Chemical exclusion of elm bark beetles from diseased elm logs.
2. Aerial photography for DED detection and evaluation.

Project: Elm Bark Beetle Populations Important to Sanitation Measures in DED--T. C. Skalbeck.

Studies:

1. Mortality factors in elm bark beetles.
2. Elm bark beetle surveillance with pheromone-baited traps.

Virginia Polytechnic Institute

Project: Physiological Processes Associated with the Causes and Control of Tree Diseases--R. J. Stipes.

Studies:

1. The nature and causes of virulence variability in C. ulmi.

University of West Virginia

Project: Pathology of Wilt Disease of Trees in the Northeast--W. L. McDonald.

Studies:

1. The nature and causes of virulence variability in C. ulmi.

Project: Biology and Control of Vascular Disease of Trees--W. L. McDonald and D. F. Hindol.

Studies:

1. Variation in pathogenicity in C. ulmi.

University of Wisconsin

Project: The Nature of DED Resistance in Ulmus--E. B. Smally and D. T. Lester.

Studies:

1. The nature of resistance to DED in elms.
2. Selection, breeding, and testing of DED resistant American elms and elm hybrids.
3. DED control with systemic fungicides.

Forest Service

Location

Northeastern Forest Experiment Station, Forest Insect and Disease Laboratory, Delaware, Ohio.

Project: Insect Vected Vascular Wilts of Forest Tree Species--J. W. Peacock, Project Leader.

Studies:

1. Systemic fungicides and pruning for DED therapy--G. F. Gregory.
2. Pheromone baited trapping systems for elm bark beetle suppression and DED control--R. A. Cuthbert and J. W. Peacock.
3. Elm bark beetle detection and population surveillance with pheromone-baited traps--R. A. Cuthbert and J. W. Peacock.
4. Effects of synthetic beetle pheromone and trapping programs on non-target insects--B. H. Kennedy and J. W. Peacock.
5. Propagation and release of elm bark beetle parasites and their impact on beetle populations--B. H. Kennedy.
6. Elm bark beetle biology and behavior--R. A. Cuthbert and E. H. Wollerman.
7. Improvement and evaluation of insecticide spray practices--J. H. Barger.
8. Improvement and evaluation of elm sanitation practices--J. H. Barger.
9. Economic analysis of DED control treatments and programs--W. N. Cannon, Jr.
10. Elm bark beetle feeding inhibitors from non-host trees--J. W. Peacock.
11. Beetle dispersal in response to pheromone--E. H. Wollerman.
12. Control of root-graft spread of DED--J. H. Barger.

Forest Service Supported Cooperative
Aid Agreements With Universities

State University of New York

College of Environmental Science and Forestry

Project: Mass trapping of Scolytus multistriatus on pheromone-baited traps to control DED--G. N. Lanier, J. B. Simeone, and R. M. Silverstein.

Studies:

1. Test effectiveness of pheromone-baited traps in reducing incidence of DED in small isolated clones of high value elms.
2. Perfect trapping systems.

University of California at Davis

Project: Evaluation of trap-out strategy for management of Scolytus multistriatus populations in California--M. C. Birch.

Studies:

1. Methods to reduce or eliminate populations of Scolytus multistriatus from small communities in eastern California by various modifications of grid trapping.

APPENDIX C

Economic Analysis Calculations

The most complete data available for use in developing an estimated economic efficiency analysis for Dutch elm disease (DED) control programs are provided in the Cannon and Worley Report ^{1/}. Their analysis of the economic impact of control measures for a 15-year period dealt with the cost and performance (control success) for three alternatives based on a 1000-tree unit (table 5).

The three alternatives utilized were (1) no control, (2) fair control performance at the highest cost, and (3) the best control performance at the lowest cost. Fair control performance is achieved if no more than 5 percent of the elms die each year. Best control performance allows no more than 1 percent mortality. High and low control costs were derived from an analysis of the range of 1972 costs for individual jobs comprising the municipal DED control program. The jobs included tree removal, sanitation, spraying, root-graft control, and survey. In 1972 dollars the control costs based on a 1000-tree unit were \$8.80 per elm tree in the population. By adding 30 percent to compensate for inflation, and including replacement costs of \$0.75 per tree, the 1977 control costs become \$12.20 per tree in the population. Addition of 40 percent for overhead raises the cost to \$17.10 per tree. The cost of the no-control alternative includes removal of dead trees and property value depreciation resulting from the loss of shade trees. The cost of the control alternatives includes treatment and removal costs plus property value depreciation attributed to shade trees lost.

^{1/} Cannon, W. N., Jr., and D. P. Worley. 1976. Dutch elm disease control: performance and costs. USDA Forest Service Research Paper NE-345, 7pp., illus.

Table 5.--Present values of no control and control costs^{2/}

Year	No Control Costs	Discounted		Fair Control Costs	Discounted		Best Control Costs	Discounted	
		6%	10%		6%	10%		6%	10%
----- (Thousands) -----									
1	\$ 2.1	\$ 1.98	\$ 1.91	\$ 4.8	\$ 4.53	\$ 4.36	\$2.7	\$ 2.55	\$ 2.45
2	4.2	3.74	3.47	5.0	4.45	4.13	3.1	2.76	2.56
3	10.5	8.82	7.89	5.9	4.95	4.43	3.6	3.02	2.70
4	16.8	13.31	11.47	7.8	6.18	5.33	3.6	2.85	2.46
5	22.9	17.11	14.23	7.8	5.83	4.84	5.0	3.74	3.10
6	25.2	17.76	14.22	7.8	5.50	4.40	5.0	3.52	2.82
7	33.3	22.15	17.09	8.7	5.79	4.46	5.0	3.32	2.56
8	23.5	14.74	10.96	9.8	6.15	4.57	5.0	3.14	2.33
9	22.9	13.55	9.71	10.4	6.16	4.41	5.0	2.96	2.12
10	10.4	5.81	4.01	14.6	8.15	5.63	5.0	2.79	1.93
11	6.2	3.27	2.17	14.6	7.69	5.12	5.9	2.63	1.75
12	2.2	1.09	0.70	15.1	7.50	4.81	4.8	2.38	1.53
13	2.2	1.03	0.64	14.8	6.94	4.29	4.5	2.11	1.30
14	1.4	0.62	0.37	14.3	6.32	3.77	5.9	2.61	1.55
15	1.4	<u>0.58</u>	<u>0.34</u>	14.6	<u>6.09</u>	<u>3.49</u>	5.0	<u>2.09</u>	<u>1.20</u>
Present Value		\$125.56	\$99.18		\$92.23	\$68.04		\$42.47	\$32.36

APPENDIX D

Annual Expenditures of 23 States Reporting for Dutch Elm Disease

<u>STATE</u>	<u>ANNUAL EXPENDITURE</u>
California	\$ 2,200,000
Colorado	963,000
Idaho	60,000
Indiana	250,000
Iowa	429,000
Kansas	400,000
Maine	50,000
Massachusetts	2,036,000
Michigan	18,000
Minnesota	6,460,000
Missouri	1,800,000
Montana	200
New Hampshire	84,000
New York	525,000
North Dakota	143,000
Ohio	60,000
Oregon	5,000
Pennsylvania	65,000
South Dakota	70,000
Vermont	100,000
West Virginia	3,000
Wisconsin	3,000,000
Wyoming	4,820
Total	\$18,726,020

APPENDIX E

Number of New State Positions Needed to Provide Technical Assistance for a National DED Program^{1/}

<u>State</u>	<u>Currently Needed</u>	<u>Potentially Needed</u>
Alabama	1	
Alaska	None	
Arizona		1
Arkansas	3	
California	2	
Colorado	2	
Connecticut	1	
Delaware	1	
Florida		1
Georgia	1	
Hawaii	None	
Idaho	1	
Illinois	1	
Indiana	1	
Iowa	1	
Kansas	1	
Kentucky	1	
Louisiana		1
Maine	1	
Maryland	1	
Massachusetts	1	
Michigan	1	
Minnesota	4	
Mississippi	1	
Missouri	2	
Montana	1	
Nebraska	1	
Nevada		1
New Hampshire	1	
New Jersey	1	
New Mexico		1
New York	1	
North Carolina	4	
North Dakota	1	
Ohio	1	
Oklahoma	1	
Oregon	1	
Pennsylvania	1	
Rhode Island	1	
South Carolina	1	
South Dakota	1	
Tennessee	1	
Texas	3	
Utah		1
Vermont	1	
Virginia	2	
Washington		1
West Virginia	1	
Wisconsin	2	
Wyoming	1	
Total	56	7

^{1/}The number of positions needed is determined by the amount of elms requiring protection within a State--1 million elms or less = 1, 1-2 million elms = 2, 2-3 million elms = 3, and greater than 3 million elms = 4.

APPENDIX F

Bibliography of Dutch Elm Disease

The following is a bibliography of the known worldwide literature on Dutch elm disease, its insect vectors, and related subjects as of April 1, 1976. Permission to use this bibliography was kindly granted by the authors and the Colorado State Forest Service. Their cooperation is gratefully acknowledged.

DUTCH ELM DISEASE - A BIBLIOGRAPHY¹
John G. Laut and Michael E. Schomaker²

The entries in this bibliography have been accumulated over the past several years. It is presented in the hope that it will be useful to those who need, or simply want, to explore the present state of knowledge about Dutch elm disease.

Ostensibly it is complete as of April 1, 1976. We would appreciate having any deficiencies brought to our attention so that amendments can be issued periodically. Reprints of papers that have been missed or subsequently published would be appreciated. Our intention now is to issue addenda on an annual basis which will be sent to all known holders of this bibliography.

The addition of a general subject index should make use of the bibliography easier. The index was developed on the basis of key words or phrases in the article title which in general restricted us to the broad categories used. Articles of a general nature were not indexed. Hopefully the next addendum will contain a more complete index.

So many people have assisted in the accumulation and, especially the preparation of this bibliography that individual acknowledgements would be too lengthy.

A simple but sincere thank you must suffice.

¹Additional copies may be obtained from the Colorado State Forest Service, Colorado State University, Fort Collins, Colorado 80523.

²Staff Forester and Plant and Insect Specialist respectively, Insect and Disease Division, Colorado State Forest Service, Colorado State University, Fort Collins, Colorado 80523.

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BIBLIOGRAPHY OF DUTCH ELM DISEASE

1. Anonymous. 1922. Krankheiten und Beschädigungen der Kulturpflanzen im Jahre 1920. Mitt. Biol. Reichsanst. Land-und Forstw. 23, 110 pp.
2. Anonymous. 1924. La Maladie des Ormes. (The Elm Disease.) Bull. Soc. Centr. For. Belgique 27 (Ann. 31): 603-607, Nov., 1924.
3. Anonymous. 1925. Erkaunkung der Ulmen. (Disease of the Elm.) Deut. Forst. - Ztg. 40:37 (Article Signed Sch.) Jan. 9, 1925.
4. Anonymous. 1925. La Maladies des Ormes. (The Elm Disease.) Bull. Soc. Centr. For. Belgique 28 (Ann. 32): 176-181 (article signed A.A.), Mar./Apr. 1925.
5. Anonymous. 1925. La Maladie des Ormes. Ann. Trav. Publics. Belgique, Ser. 2, 78, pp. 121-124.
6. Anonymous. 1926. Een Ziekte (?) in de Iepenboomen. (A Disease (?) of the Elm Tree.) Floralia 47: 761-2, Dec. 3, 1926.
7. Anonymous. 1928. Dutch Elm Disease in England. Gard. Chron. III, 83: 273-4, Apr. 21, 1928.
8. Anonymous. 1928. Dutch Elm Disease. Nat. Nurseryman 36: 152, May 1928.
9. Anonymous. 1928. De Verwekker der Iepenziekte. (The Cause of the Elm Disease.) Floralia 49: 364-5, June 8, 1928.
10. Anonymous. 1929. "Almdödon" är pa Marsch. (The "Elm Death" is on the March.) Skogen 16: 319-20, (Article Signed Sec.), June 1, 1929.
11. Anonymous. 1930. Dutch Elm Disease Found Here. Off. Record U. S. Dept. Agr., No. 36, 9:3 4S, 1930.
12. Anonymous. 1930. Dutch Elm Disease Found in the United States. Plant Disease Reporter 14:183.
13. Anonymous. 1930. The Elm Bark Beetle and the Dutch Elm Disease. Gard. Chron. III, 87:77, Feb. 1, 1930.
14. Anonymous. 1930. (No title). Nature (London) 125:252, Feb. 15, 1930.
15. Anonymous. 1930. Der Erreger des Ulmensterbens Entdeckt. (*Graphium ulmi*). (The Cause of the Elm Disease Discovered. * * * *. Die Umschau 34:773, (Article Signed Fr.), Sept. 20, 1930. [Repr: Gärtner - Börse 12:593, 1930.]
16. Anonymous. 1930. Ulemnsterben, Ulmensplintkäfer und Schutzimpfung. (Elm Disease, Elm Bark Beetles and Immunization.) Entom. Ztschr. 44:231, Nov. 8, 1930.

17. Anonymous. 1930. (No title). *Nature* (London) 126:817-8, Nov. 22, 1930.
18. Anonymous. 1930. Holz Gesunder und Kranker Ulmen. (Sound Wood and Diseased Elm.) *Deut. Forst.-Ztg.* 45:1314-5 (Article Signed Rrs), Dec. 1930.
19. Anonymous. 1931. Ulmenstergen in Sachsen. (Elm Disease in Saxony). *Forstl. Wochenschrif Silva* 19:112, Mar. 27, 1931.
20. Anonymous. 1931. La Maladie des Ormeaux. (The Disease of the Elms.) *Rev. Zool. Agr. and Appl. Entom.* 30:35-6, Feb. 1931.
21. Anonymous. 1931. La Maladie et les Ennemis des Ormes. (The Disease and Enemies of the Elm.) *Rev. Zool. Agr. and Appl. Entom.* 30: 41-7, see pp. 41-4, Mar. 1931.
22. Anonymous. 1931. La Maladie des Ormes. (The Elm Disease.) *Bull. Soc. Centr. For. Belgique* 34 (Ann. 38): 171-2 (Article Signed R), Apr. 1931.
23. Anonymous. 1931. Zur Bekämpfung des Ulmensterbens. (The Control of the Elm Disease.) *Prakt. Ratgeb. Obst.-u. Gartenb.* 46:355, July 26, 1931.
24. Anonymous. 1931. La Maladie et les Ennemis des Ormes. (The Disease and Enemies of the Elm.) *Bull. Soc. Centr. For. Belgique* 34 (Ann. 38): 296-302, July 1931.
25. Anonymous. 1931. Elm Trees Threatened by New Disease. *Jour. of Forestry* 29:959, Oct. 1931.
26. Anonymous. 1931. Dépérissement des Ormes. (Dying of the Elms.) *Rap. Inst. Rech. Agron. (Paris)* 9:440, 1931.
27. Anonymous. 1932. Dutch Elm Disease at Versailles. *The Shade Tree* 5 (3):5.
28. Anonymous. 1932. The Dutch Elm Disease. *Plant Disease Reporter* 16:125.
29. Anonymous. 1932. Dutch Elm Disease in France. *Gard. Chron.* III, [91]: Jan. 9, 1932.
30. Anonymous. 1932. Progress of Elm Disease in Great Britain. U. S. Dept. of Agr., For. Serv. *Forest Worker* 8:16, Mar. 1932.
31. Anonymous. 1932. Serious Menace Presented by Dutch Elm Disease. *Amer. Nurseryman* 56:109, Oct. 1, 1932.

32. Anonymous. 1932. (No title). Gard. Chron. III, 92:315, Oct. 29, 1932.
33. Anonymous. 1932. (No title). Inst. f. Angew. Bot. Hamburg Jahrb. Jan. 1 to Dec. 31, 1931. 84, (Control by Pruning), 1932.
34. Anonymous. 1932. Elm Disease. The Present Position. Scott. For. Jour. 46:194-6, Oct. 1932.
35. Anonymous. 1932. Das Ulmensterben. (The Elm Disease.) Mitt. Deut. Dendrol. Ges. 44:416, 1932.
36. Anonymous. 1933. A Challenge. The Shade Tree 6(7):3-4.
37. Anonymous. 1933. The Dutch Elm Disease. Science n.s. Suppl 78:10.
38. Anonymous. 1933. Dutch Elm Disease in the United States This Year. Plant Disease Reporter 17:156.
39. Anonymous. 1933. The Dutch Elm Disease. Plant Disease Reporter 17:167.
40. Anonymous. 1933. Quarantine Against the Dutch Elm Disease. Science n.s. 78:572-573.
41. Anonymous. 1933. Iepen ziekte-onderzoek. Tijdschr. Plantenz. 39:16, Jan. 1933.
42. Anonymous. 1933. Dutch Elm Disease (*Graphium ulmi*). U. S. Dept. Agr., Plant Disease Reporter Suppl. 84:45, Mar. 15, 1933.
43. Anonymous. 1933. Comment on Combat la Maladie de l'Orme en Hollande. (How the Elm Disease is Fought in Holland) Bull. Soc. Centr. For. Belgique 36 (Ann. 40):213-5 (Article Signed R. (H.)), May 1933.
44. Anonymous. 1933. Das Ulmensterben. Steuungnahme der Biologischen Reichsanstalt zu dem Aufsatz "Die Wahre Ursache des Grossen Ulmensterbens." (The Elm Disease. Stand Taken by the Biological State Institute as to the Article "The True Cause of the Widespread Elm Disease".) Möllers Deut. Gärt-Ztg. 48:207-8, June 21, 1933.
45. Anonymous. 1933. The Dutch Elm Disease in New Jersey. Science 78:117-8, Aug. 11, 1933.
46. Anonymous. 1933. The Dreaded Dutch Elm Disease Breaks Out Anew. Amer. Nurseryman 58:43, Aug. 15, 1933.
47. Anonymous. 1933. Dutch Elm Disease in New York. Amer. Nurseryman 58:58-9, Sept. 1, 1933.

48. Anonymous. 1933. Elm Disease in Germany. Gard. Chron. III, 94:267, Oct. 7, 1933.
49. Anonymous. 1933. (No title). Science 78:383, Oct. 27, 1933.
50. Anonymous. 1933. Will the Elm Go the Way of the Chestnut? Amer. Agriculturist 130:444, Oct. 28, 1933.
51. Anonymous. 1933. Sur la Présence du *Graphium ulmi* Dans le Sudouest de la France. (On the Presence of * * * * in the Southwest of France.) Rev. Path. Veg. Entom. Agr. 20:252, Oct. 1933.
52. Anonymous. 1933. Elm Disease in Great Britain. Nature (London) 132:707, Nov. 4, 1933.
53. Anonymous. 1933. Some Facts About the Dutch Elm Disease. Flor. Exch. 81:18, Nov. 4, 1933.
54. Anonymous. 1933. United Action Urged Against the Dutch Elm Disease. Flor. Exch. 81:19-20, (Article Signed S.), Nov. 4, 1933.
55. Anonymous. 1933. Dutch Elm Disease in the United States. Gard. Chron. III, 94:374, Nov. 18, 1933.
56. Anonymous. 1933. Dutch Elm Disease in the United States. Nature (London) 132:788, Nov. 18, 1933.
57. Anonymous. 1933. Elm Disease in Great Britain. Empire For. Jour. 12:264-5, Nov. 1933.
58. Anonymous. 1933. Dutch Elm Disease. U. S. Dept. Agr. Yearbk. 1934 (for 1935):71.
59. Anonymous. 1933. (No title). Rap. Inst. Rech. Agron. (Paris) 11:419, 1933.
60. Anonymous. 1933. Bekämpfung des Ulmensterbens. (Control of the Elm Disease.) Deut. Forst.-Ztg. 48:669, - - - - -, 1933.
61. Anonymous. 1934. Dutch Elm Disease. The Shade Tree 7(7):3-4.
62. Anonymous. 1934. Dutch Elm Disease. Plant Disease Reporter 18:50-51.
63. Anonymous. 1934. The Elm Tree Disease in New York and New Jersey. Science n.s. 80:200.
64. Anonymous. 1934. Dutch Elm Disease. The Shade Tree 7(9):3-4.

65. Anonymous. 1934. Connecticut Rallying to Save Her Priceless Elms. New Haven Register Oct. 14, 1934.
66. Anonymous. 1934. Present Status of the Dutch Elm Disease. Plant Disease Reporter 18:167.
67. Anonymous. 1934. Elm Disease in Great Britain. Science n.s. 80:471-472.
68. Anonymous. 1934. Kort Verslag van het Iepen ziekte-onderzoek Verricht op het Phytopathologisch Laboratorium Willie Commelin Scholten te Baarn, Gedurende 1933. (Short Report on the Dutch Elm Disease Research of the Phytopathological Lab. * * * * During 1933.) Tijdschr. Plantenz. 40:88-90, Mar. 1934.
69. Anonymous. 1934. Nochmals: Der Ulmented Besiegt? (Once Again: Is the Die-Back of Elm Overcome?) Blumen u. Pflanzenb. Vereinigt. Gartenw. 38:199, Apr. 13, 1934.
70. Anonymous. 1934. Elm Disease Problem. Amer. Nurseryman 59:4, May 1, 1934.
71. Anonymous. 1934. Prohibiting the Importation Into the Dominion of Canada of Elms, Elm Logs, or Burls from all countries. (Regulation #17, Foreign 1st Revision, Effective May 9, 1934). P.C. #342 Under the Destructive Insect and Pest Act, Canada.
72. Anonymous. 1934. Saving the American Elm. Amer. For. 40:213, May 1934.
73. Anonymous. 1934. The Dutch Elm Disease. Science 79:516-7, June 8, 1934.
74. Anonymous. 1934. A Challenge to New Jersey. The Shade Tree (N.J.) 7:1-2, June 1939.
75. Anonymous. 1934. Ulmensterben. (The Elm Disease.) Kranke Pflanze 11:74, June 1934.
76. Anonymous. 1934. Dutch Elm Disease. Gard. Chron. III, 96:32, July 14, 1934.
77. Anonymous. 1934. Destruction of Trees by the Dutch Elm Disease. Science Suppl. 80:6-7, July 20, 1934.
78. Anonymous. 1934. Dutch Elm Disease Field Meeting -- Wednesday, Aug. 1, 1934. The Shade Tree (N.J.) 7:2-3, July 1934.
79. Anonymous. 1934. Dutch Elm Disease. Gard. Chron. III, 96:126 (Letter to the Editor Signed W.J.P. Hitchen), Aug. 18, 1934.

80. Anonymous. 1934. Dutch Elm Disease Spreading. Amer. Agriculturist 131:(456), Aug. 18, 1934.
81. Anonymous. 1934. The Elm Disease Exhibit at the N.Y. Botanical Garden. Science 80:180, Aug. 24, 1934.
82. Anonymous. 1934. The Elm Tree Disease in New York and New Jersey. Science 80:200, Aug. 31, 1934.
83. Anonymous. 1934. Dutch Elm Disease Shows Alarming Gains. Amer. For. 40:420, Sept. 1934.
84. Anonymous. 1934. Dutch Elm Disease in the United States. Gard. Chron. III, 96:276, Oct. 20, 1934.
85. Anonymous. 1934. New England Organizes Against Dutch Elm Disease. Amer. For. 40:479, Oct. 1934.
86. Anonymous. 1934. Elm Disease in Great Britain. Science 80:471-2, Nov. 23, 1934.
87. Anonymous. 1934. Elm Disease in Great Britain. Gard. Chron. III, 96:365, Nov. 24, 1934.
88. Anonymous. 1934. The American Elm-Now or Never. Amer. For. 40:521, Nov. 1934.
89. Anonymous. 1934. (No title). Science 80:557-8, Dec. 14, 1934.
90. Anonymous. 1934. Connecticut Creates Committee on Dutch Elm Disease Control. Amer. For. 40:591, Dec. 1934.
91. Anonymous. 1934. Funds for Control of Dutch Elm Disease Still Lacking. Amer. For. 40:582, Dec. 1934.
92. Anonymous. 1934. (No title). Proc. Nat. Shade Tree Conf. 10 (1934):78-95.
93. Anonymous. 1935. Dutch Elm Disease Past, Present, Future. The Shade Tree 8(1):2-3.
94. Anonymous. 1935. Prove Dutch Elm Disease Carried by Bark Beetle. Journal For. 33:82-83.
95. Anonymous. 1935. Dutch Elm Disease Territory Rescued by Force of 4,000 men. USFS Service Bulletin Vol XIX (9) Sept.
96. Anonymous. 1935. Fight Against Dutch Elm Disease in Full Swing in Three States. Plant Disease Reporter 19:14.

97. Anonymous. 1935. Present Status of the Dutch Elm Disease. Plant Disease Reporter 19:216-218.
98. Anonymous. 1935. Dutch Elm Disease Eradication. Plant Disease Reporter 19:237-238.
99. Anonymous. 1935. Elm Disease in England. U. S. Dept. Agr. Daily Digest 58:2-3.
100. Anonymous. 1935. Dutch Elm Disease Eradication. Plant Disease Reporter 19:259-260.
101. Anonymous. 1935. Dutch Elm Disease Eradication. Plant Disease Reporter 19:293.
102. Anonymous. 1935. Dutch Elm Disease Eradication. Plant Disease Reporter 19:303.
103. Anonymous. 1935. Our Elms are Threatened. Conn. For. Park. Association No. 26:1-4 5a 1935.
104. Anonymous. 1935. (No title). Science 81:66, Jan. 18, 1935.
105. Anonymous. 1935. Ein Mittel Gegen das Ulmensterben. (A Remedy for the Elm Disease.) Oesterr. Vierteljahresschr. Forstw., n.f. 53:12-3, Jan. 1935.
106. Anonymous. 1935. (No title). Jour. S.E. Agr. Coll. Wye 35:22-4, Jan. 1935.
107. Anonymous. 1935. P.W.A. Funds for Elm Protection. Amer. For. 41:33, Jan. 1935.
108. Anonymous. 1935. Seek Funds to Save Elms. Amer. Nurseryman 61:14, Feb. 1, 1935.
109. Anonymous. 1935. Dutch Elm Disease Control Progresses. Amer. For. 41:86, Feb. 1935.
110. Anonymous. 1935. What Can I as a Private Citizen do to Protect My Elm Trees? Amer. For. 41:83, Feb. 1935.
111. Anonymous. 1935. Fight on Dutch Elm Disease. Amer. Nurseryman 61:6, Mar. 1, 1935.
112. Anonymous. 1935. New Elm Quarantine. Amer. Nurseryman 61:6, Mar. 1, 1935.

113. Anonymous. 1935. Dutch Elm Disease Quarantine in Force. Federal Order Effecting 3 States in Effect February 25. Flor. Exch. 84:13, Mar. 2, 1935.
114. Anonymous. 1935. Looking Ahead for the Elms. Amer. For. 41:118, Mar. 1935.
115. Anonymous. 1935. Dutch Elm Disease Control Work Makes Progress. Amer. For. 41:132, Mar. 1935.
116. Anonymous. 1935. Fight on Elm Disease Continues. Amer. For. 41:290, June 1935.
117. Anonymous. 1935. (No title). Science 82:59, July 19, 1935.
118. Anonymous. 1935. Notes from the Connecticut Agricultural Experiment Station. Science 82:97, Aug. 2, 1935.
119. Anonymous. 1935. Dutch Elm Disease Control. Amer. Nurseryman 62:4, Aug. 15, 1935.
120. Anonymous. 1935. \$2,500,000 for Dutch Elm Disease Control. Amer. For. 41:382, Aug. 1935.
121. Anonymous. 1935. (No title). Science Suppl. 82:9, Sept. 20, 1935.
122. Anonymous. 1935. (No title). Science Suppl. 82:8, (DED in England), Sept. 27, 1935.
123. Anonymous. 1935. The Great Fight Against the Dutch Elm Disease. Nat. Nurseryman 43:8, Sept. 1935.
124. Anonymous. 1935. Survey of 11th National Shade Tree Conference. The Shade Tree (N.J.) 8:1-10, see p. 3, Sept. 1935.
125. Anonymous. 1935. (No title). Science 82:324, Oct. 4, 1935.
126. Anonymous. 1935. (No title). Flor. Exch. 85:19, Oct. 5, 1935.
127. Anonymous. 1935. Inland-rundschau. Bremen. (Inland Review ****.) Blumen u. Pflanzenb. Vereinigt Gartenw. 39:520, Oct. 18, 1935.
128. Anonymous. 1935. The Elm Disease in 1935. Gard. Chron. III, 98:433, Dec. 21, 1935.
129. Anonymous. 1935. What is Being Done to Conquer the Elm Disease in the Netherlands? Circular Distributed at the International Botanical Congress at Baarn, Holland, 1935.

130. Anonymous. 1935. (No title). Proc. Nat. Shade Tree Conf. 11 (1935): 146-51.
131. Anonymous. 1935. Ein Beitrag zum Studium des Ulmensterbens in der Tschechoslowaki. (A Report on the Study of the Elm Disease in Czechoslovakia.) Ztschr. Angew. Entom. 22:508-9, 1935.
132. Anonymous. 1936. Fight Against Dutch Elm Disease Continued Through Snow and Sleet. U. S. Dept. Agr. Plant Disease Reporter 2:19, 31, Mar. 1936.
133. Anonymous. 1936. Dutch Elm Disease and its Recognition. Pract. Micros. 2:19,31, Mar. 1936.
134. Anonymous. 1936. Wallace Asked to Clarify Charge Elms are Doomed. Amer. For. 42:132, Mar. 1936.
135. Anonymous. 1936. Non-professional Diagnosis Jeopardizes the American Elm. The Shade Tree (N.J.) 9:1-3, Mar. 1936.
136. Anonymous. 1936. Extend Elm Disease Control. Amer. For. 43:230, May 1936.
137. Anonymous. 1936. In Memoriam. Mej. Dr. Chr. J. Buisman. Nederl. Boschb. - Tijdschr. 9:149, May 1936.
138. Anonymous. 1936. Autogiro Scouts Elms. Amer. Nurseryman 64:10, Oct. 1, 1936.
139. Anonymous. 1936. Eleventh Annual Meeting. The Shade Tree (N.J.) 9:1-3, see p. 2, Oct. 1936.
140. Anonymous. 1936. Elm Disease Control. Amer. Nurseryman 64:11, Nov. 1, 1936.
141. Anonymous, 1936. On to Victory. Amer. For. 42:515, Nov. 1936.
142. Anonymous. Connecticut Elm Order. Amer. Nurseryman 64:14, Dec. 1, 1936.
143. Anonymous. 1937. *Ulmus pumila*. Versuchsergebnisse über das Ulmensterben. (* * * *. Result of Investigations on the Elm Disease.) Möllers Deut. Gärt.-Ztg. 52:23, Jan. 21, 1937.
144. Anonymous. 1937. Elms. Wood (London) pp. 3-4, Jan. 1937.
145. Anonymous. 1937. (No title). Science Suppl. 85:7, Mar. 26, 1937.
146. Anonymous. 1937. The Elm's Rendezvous with Death. Amer. For. 43:221, May 1937.

147. Anonymous. 1937. Eradication of the Dutch Elm Disease. Science N.S. 86:2239, 1937.
148. Anonymous. 1938. Elm Disease. Br. For. Comm. Leaflet 19.
149. Anonymous. 1938. Elm Disease Eradication in the United States. Chron. Bot. 4: 4-5 pp. 429-432.
150. Anonymous. 1938. Amtliche Pflanzenschutzbestimmungen (Official Plant Protection Regulation.) Beil. Nachr. Bl-dtsch. Pfl. Sch. Dienst. X:74-90.
151. Anonymous. 1938. W.P.A. Crews find Copper Sulphate Against Dutch Elm Disease. Jour. of Forestry 36:342, 1938.
152. Anonymous. 1939. Dutch Elm Disease in the United States. 1930-1938. (with maps) Plant Disease Reporter 23(6):91-114.
153. Anonymous. 1939. Elm Disease. Quart. J. For. 33:112-113, 1939.
154. Anonymous. 1939. Modification of Dutch Elm Disease Quarantine Regulations. U.S.D.A., B.E.P.Q. 1939.
155. Anonymous. 1939. Present Status of the Dutch Elm Disease. Plant Disease Reporter XXIII:286-288.
156. Anonymous. 1940. Present Status of the Dutch Elm Disease. Plant Disease Reporter XXIV:349-350.
157. Anonymous. 1940. Report of Proceedings, Third International Congress for Microbiology, New York, 1939. International Association of Microbiologists, N.Y.
158. Anonymous. 1941. Dutch Elm Disease Quarantine. Revision of Quarantine and Regulations Effective October 1, 1940. U.S.D.A., B.E.P.Q.
159. Anonymous. 1941. Dutch Elm Disease in 1941. Plant Disease Reporter 25:450-451.
160. Anonymous. 1941. Wissenschaftlicher Jahresbericht der Biologischen Reichsanstalt für Land und Forstwirtschaft, 1940 (Scientific Annual Report of the National Biological Institute for Agriculture and Forestry). Mitt. Biol. Anst. (Reichsanst.) Berl., 65.
161. Anonymous. 1942. Dutch Elm Disease Quarantine, Revision of Quarantine and Regulations Effective 1941. U.S.D.A., B.E.P.Q.

162. Anonymous. 1942. Service and Regulatory Announcements. List of Intercepted Plant Pests, 1941. U.S.D.A.
163. Anonymous. 1944. Report of the Director for the Year Ending 31, Oct. 1943. Bull. Conn. Agric. Exp. Sta. 477:52-56, 1944.
164. Anonymous. 1946. Report of the Chief of the Bureau of Entomology and Plant Quarantine. Agricultural Research Administration, 1945-1946.
165. Anonymous. 1947. Notice of Lifting of the Domestic Dutch Elm Disease Quarantine. B.E.P.Q., U.S.D.A.
166. Anonymous. 1947. Method and Time of Transmission of Dutch Elm Disease in Quebec. For. Insect. Invest. Bi-m. Progr. Rep. No. 3. 1947.
167. Anonymous. 1947. Dutch Elm Disease Quarantine. B.E.P.Q., U.S.D.A. 1947.
168. Anonymous. 1947. Elm Disease: *Ceratostomella ulmi*. Leaflet. For Comm., London. 19.
169. Anonymous. 1947. *Ceratostomella ulmi* Buisman. C.M.I. Dis. Maps of Plant Diseases No. 36 (2nd Edition).
170. Anonymous. 1948. DDT Helps Reduce the Spread of Dutch Elm Disease. Agric. News Letter 16:11-12.
171. Anonymous. 1948. Elm Bark Beetle Conference Committee Report on DED Control. Trees, Cleveland 8(3), 1948.
172. Anonymous. 1956. Essentials of Dutch Elm Disease Control. A Transcript of the Proceedings of a Second Statewide Conference on the Control of Dutch Elm Disease. Illinois State Chamber of Commerce, Chicago, 83pp.
173. Anonymous. 1957. Dutch Elm Disease in Iowa. Iowa State College, Dept. of Bot. and Plant Path. and Dept. of Ent. Ext. Pub. P.D. and I.C. 2:1-3.
174. Anonymous. 1957. Occurrence of *Ceratocystis ulmi* (Buism.) C. Moreau in New Brunswick, Can. Dept. For., For. Ent. and Path. Branch, Bi-Mon. Prog. Rept. 13(6):1.
175. Anonymous. 1958. An Up-to-date Report in Dutch Elm Disease. Arborist's Bulletin Oct. 1958.

176. Anonymous. 1958. Dutch Elm Disease. Can. Dept. of Agr. Publ. 1010 Revised.
177. Anonymous. 1958. Elm Disease, *Ceratostomella ulmi*. For. Comm. Leaflet 19, 8pp.
178. Anonymous. 1961. The Dutch Elm Disease. Coop. Economic Insect Report. U.S. Dept. Agr. Vol. II, No. 39:917.
179. Anonymous. 1962. *Scolytus multistriatus*. The Tiny Beetle that Can Kill all Canada's Elms. Canada Monthly Dec. 1962.
180. Anonymous. 1962. Chemical Helps Fight Dutch Elm Disease. Science News Letter 1962, 81: 120.
181. Anonymous. 1963. Elm Bark Beetle. U. S. Dept. Agr. Leaflet 185.
182. Anonymous. 1963. Embattled Elms. Time 1963, 81 (19): 46, 51.
183. Anonymous. 1963. Shot in the Trunk. Newsweek 1963, 62: 50.
184. Anonymous. 1964. A Review of the Dutch Elm Disease. Bi-Mon. Prog. Rept. 20(4):8, 1964.
185. Anonymous. 1964. Instructional Manual: Implantation of Bidrin Insecticide into Elm Trees. Shell Chem. Co., N.Y.
186. Anonymous. 1964. Let's Save Our Elms! Minnesota Dept. of Agr. Circular 529.
187. Anonymous. 1965. Chemical Retards Spread of Dutch Elm Disease. Science News Letter 1965, 87: 8.
188. Anonymous. 1967. Dutch Elm Disease. U. S. Dept. Agr. Delaware, Ohio: Proceedings of Meeting Held June 29-30, 1967.
189. Anonymous. 1968. Interplant to Control Dutch Elm Disease. American City 1968, 83(4): 12.
190. Anonymous. 1969. Elm Research Institute. Weeds Trees and Turf 9(5):14-17.
191. Anonymous. 1969. Dutch Elm Disease...Threat to Colorado. Colorado Farm and Home Research 19(3).
192. Anonymous. 1969. It's Freer's Elm Arrester. Weeds Trees and Turf 9(5):20-21.

193. Anonymous. 1970. Municipal Arborists Survey Reveals More Funds for Tree Care. Weeds Trees and Turf 9(12):16.
194. Anonymous. 1970. Save Our Shade. Michigan Science in Action 15: 12-13.
195. Anonymous. 1970. Elms Found Resistant to Dutch Elm Disease. Weeds Trees and Turf 9(12):68.
196. Anonymous. 1970. Hybrid Elm. Ag. Res. Ang. 1970.
197. Anonymous. 1970. Closer to Curing the Elm. U. S. Dept. Agr., Agricultural Research 1970, 18(9):3.
198. Anonymous. 1971. DED Spread Rapid. Metro. Horticulture 6(2):10p.
199. Anonymous. 1971. Federal Entomologist Blesses Methoxychlor for Dutch Elm Disease. Weeds Trees and Turf p. 38-39.
200. Anonymous. 1971. Elm Fungicide. Chemical and Engineering News Aug. 16.
201. Anonymous. 1971. (No title) Weeds Trees and Turf Apr. 1971. p. 62.
202. Anonymous. 1972. DED Control Kindles Strong Arborist Interest. Weeds Trees and Turf 7:72.
203. Anonymous. 1972. Dutch Elm Disease no Immediate Relief. Nature 239:244.
204. Anonymous. 1972. Infrared Looks at Trees-Aircraft Scanning of Dutch Elm Diseased Trees in Denver, or Satellite Scanning to Timber on Earth-Infrared Does it all. Forest Industries July, p. 36.
205. Anonymous. 1972. Internal Transmission of Dutch Elm Disease. Nature 240:253.
206. Anonymous. 1972. Methoxychlor Replaces DDT for Dutch Elm Control. Crops & Soils Magazine p. 21-22, February.
207. Anonymous. 1972. Photography Arms Geographers for Battle With Elm Disease. Planter, Kuala Lumpur 48(550):21-23.
208. Anonymous. 1973. Control of Dutch Elm Disease. Chemistry in Canada May, pp. 9-10.
209. Anonymous. 1973. Latest Report on Dutch Elm Disease. Grounds Maintenance Feb., pp. 50-54.

210. Anonymous. 1973. New Ways to Fight Dutch Elm Disease. Better Homes and Gardens May.
211. Anonymous. 1973. Tree Injection Systems - Modern Clinical Method to Healthier Trees. Weeds Trees and Turf April, p. 14.
212. Anonymous. 1973. General Conslusions DED. Proceedings IUFRO Conference, Sept. pp. 93.
213. Anonymous. 1974. What's That Thing on that Tree? Q.A. on For. Res. No. 1:6p. USFS N.E. For. Exp. Sta.
214. Anonymous. 1974. American Elm--Going, Going--? National Agricultural Chemicals Newsletter Oct. 21, 1974. pp 1.
215. Anonymous. 1974. Dutch Elm Disease Pamphlet. Great Lakes Forest Research Center Canadian Forestry Service, Sault Ste. Marie.
216. Anonymous. 1974. Dutch Elm Disease Survey 1974. Trees 37(2):46-47.
217. Anonymous. No date. Protector of Elms???? Northeastern Forest Experiment Station, Forestry Science Photo Story #2.
218. Anonymous. No date. Researching Dutch Elm disease. Forestry Science #9.
219. Anonymous. No date. Forestry Scientists Find: "Tasty" Bark Draws Elm Disease Carriers. USFS Forestry Science Photo Story #9.
220. Anonymous. No date. Dutch Elm Disease. Can. For. Serv. Fact Sheet. For. Info. See Ottawa.
221. Anonymous. No date. What is Being Done to Conquer the Elm Disease in the Netherlands? A Printed Two Page Article Apparently by the Committee of Eight for the Netherlands.
222. Administration des Eaux et Forets. 1931. La Maladie et les Ennemis des Ormes. Comm. d'Etudes des Ennemis des Arbes. Bull. 7:1-8.
223. Agrios, G.N. 1969. Plant Pathology. New York: Academic Press, 1969.
224. Ahrens, W. E. et. al. 1935. A List of References to Literature on the Dutch Elm Disease. Mimeographed Copy by U.S. Dept. Agr. Bur. Pl. Ind., Div. For. Path. 1-29. F 1935.
225. Ahrens, W. E. 1940. The Practicability of Detecting Dutch Elm Disease by Trunk Sampling. Phytopath. 30:521-527.

226. Al-Azawi, A. F. and J. E. Casida. 1958. The Efficiency of Systemic Insecticides in the Control of the Smaller European Elm Bark Beetle. Jour. Econ. Ent. 51:788-790.
227. Al-Azawi, A. F. and D. M. Norris, Jr. 1959. Experimental Prevention of Bark Beetle Transmissions of *Ceratocystis ulmi* (Buis.) Moreau With Systemic Insecticide Chipman R-6199. Jour. Econ. Ent. 52:902-904.
228. Al-Azawi, A. F. et al. 1961. Hazards Associated with the Implantation of Terram into Elm Trees for Dutch Elm Disease Control. Jour. Econ. Ent. 54:127-129.
229. Alexandri, A. V. 1932. (The Dutch Elm Disease in Rumania). Bull. Soc. Study. Stunte Nat. Bucharest III 16 pp.
230. Amos, R. E. and R. G. Burrell. 1967. Serological Differentiation in *Ceratocystis*. Phytopath. 57:32-34.
231. Anderson, M. L. 1961. Elm Disease. Nature Lond. 189:886-887.
232. Angell, M. 1971. Trichlorophenylacetic Acid and Xylem Development in *Ulmus*. Thesis. (Feb. Iowa State Univ.) in Phytopath. News 4(12).
233. Angell, M. P. and H. S. McNabb, Jr. 1970. Toxin Production by Isolates of *Ceratocystis ulmi*. Proc. Iowa Academy of Science 77:14-18.
234. Ansaloni, A. 1934. (The Die-back of Elms and the Distribution in Italy of the Siberian Elm). Bologna, Edit. Selva. 118 pp.
235. Arisumi, T. and D. J. Higgins. 1961. Effect of Dutch Elm Disease on Seeding Elms. Phytopath. 51:847-850.
236. Arnaud, G. 1931. Research on Dying of Roadside Trees. Ann. Epiph. 17:249-323.
237. Arnaud, G. 1934. (The Dying of Elms [*Graphium ulmi*]). Prog. Agr. et Vitic. 102:260-265.
238. Arnaud, G. 1939. La Resistance des Ormes a la Maladie (*Graphium ulmi*). Ann. Ephiphyt. N. S. V 41-49.
239. Arnaud, G. and J. Barthelet. 1931. La Maladie de l'Orme. Rev. Path. Veg. et Ent. Agr. 18:28-32.
240. Arnaud G. and J. Barthelet. 1931. Recherches sur les Déperissements des Arbes d'Alignement. (Investigations on the Dying of Road-side Trees). Ann. Epiph. 17:249-323, See pp. 307-23, July-Aug., 1931.

241. Asante, G. S. 1964. Biochemical Studies of *Ceratocystis ulmi* (Buisman) Moreau. Abstract of Thesis in Dissert. Abstr. 24 (9), (3522), Cornell University.
242. Asante, G. S. and A. L. Neal. 1964. Characterization of Fungistatic Substances Produced by a *Bacillus* Antagonistic to *Ceratocystis ulmi*. Phytopath. 54:819-822.
243. Asante, G. S. and A. L. Neal. 1964. On the Glucose-6-phosphate Dehydrogenase of *Ceratocystis ulmi*. Arch. Biochem. 108:65-71.
244. Atanasov, D. and St. Martinow. 1932. (The Dutch Elm Disease, *Ceratostomella* (Schwarz) Buisman. *Graphium ulmi* Schwarz). Yearbook Univ. of Sofia Fac. of Agr. 11:71-86.
245. Babel. 1932. Wie Steht's mit dem Ulmensterben? (What is the Status of the Elm Disease?). Blumen-u Pflanzenbau (Berlin) 47:8-9 Illustrated.
246. Baker, J. E. and D. M. Norris. 1967. A Feeding Stimulant for *Scolytus multistriatus* (Coleoptera: Scolytidae) Isolated From the Bark of *Ulmus americana*. Ann. Ent. Soc. Amer. 60:1213-1215.
247. Baker, J. E. and D. M. Norris. 1968. Further Biological and Chemical Aspects of Host Selection by *Scolytus multistriatus*. Ann. Ent. Soc. Amer. 61:1248-1255.
248. Baker, J. E., F. P. Rainey, D. M. Norris and F. M. Strong. 1968. p-Hydroxybenzaldehyde and Other Phenolics as Feeding Stimulants for the Smaller European Bark Beetle. For. Science 14:91-95.
249. Baker, W. D. 1941. Type of Wood Preferred by Coleoptera Commonly Found in Decadent Parts of Living Elm Trees. Jour. Econ. Ent. 34:475-476.
250. Bally, W. 1928. Over de Hollandsche Iepenziekte. (On the Dutch Elm Disease). Bergcultures 3:645-7.
251. Bancroft, H. 1935. Elm Notes. Gard. Chron. III. 99:104-5, 268; 100:127, 392-3, 429-30, 445-6, Illustrated, Feb. 15, Apr. 25, Aug. 15, Nov. 28, Dec. 12 and 19, 1936.
252. Banfield, W. M. 1937. Distribution of Spores of Wilt-inducing Fungi Throughout the Vascular System of the Elm by the Sap Stream. Phytopath. 27:121-122 (Abstr.).

253. Banfield, W. M. 1938a. Effect of Nitrogen on Inception and Development of Dutch Elm Disease on American Elm. *Phytopath.* 28:2 (Abstr.).
254. Banfield, W. M. 1938b. Relation of Sap Flow, Vessel Length, Sport Distribution to Development of Dutch Elm Disease in American Elm. *Phytopath.* 28:3 (Abstr.).
255. Banfield, W. M. 1941. Distribution by the Sap Stream of Spores of Three Fungi that Induce Vascular Wilt Diseases of Elm. *J. Agr. Research* 62:637-681.
256. Banfield, W. M. 1941. Relation of Vessel Length at Infection Points to Extent of Vascular Invasion in American Elm by *Ceratocystis ulmi*. *Phytopath.* 31:2 (Abstr.).
257. Banfield, W. M. 1947. Dutch Elm Disease Recurrence in American Elms in Relation to the Extent of Vascular Invasion by *Ceratocystis ulmi* in the Year of Disease Incidence. *Phytopath.* 37:1 (Abstr.).
258. Banfield, W. M. 1948. Time and Locus of Infection of American Elms in Relation to Extent of Vascular Invasion by *Ceratostomella ulmi*. *Phytopath.* 38:2 (Abstr.).
259. Banfield, W. M. 1964. Dutch Elm Disease Recurrence and Recovery in American Elm. Research Manuscript.
260. Banfield, W. M. 1968. Dutch Elm Disease Recurrence and Recovery in American Elm. *Phytopath. Zeits.* 62:21-60.
261. Banfield, W. M. and A. L. Smith. 1936. Growth and Distribution of *Ceratostomella ulmi* in Tissues of Elm. *Phytopath.* 26:86 (Abstr.).
262. Banfield, W. M., E. G. Rex and Curtis May. 1947. Recurrence of Dutch Elm Disease in American Elms in Relation to Tree Stature. *Phytopath.* 37:1 (Abstr.).
263. Bannwart, C. 1933. A Report of the Conference at Washington About the Dutch Elm Disease. *The Shade Tree (N.J.)* 6:1-3, Nov., 1933.
264. Barbers, F. H. and J. J. Pratt. 1951. Development of Insect Resistance to Insecticides - II. U.S. Dept. Agr., Bur. Ent. Plant Quarant. E-818, p. 21.
265. Barger, J. H. 1971. Field and Laboratory Evaluation of Methoxychlor for Dutch Elm Disease Vector Control. Ph.D. Diss. The Ohio State Univ. 69 pp.

266. Barger, J. H. and Roy A. Cuthbert. 1971. Statistical Correlations Between GLC Assay and Smaller European Elm Bark Beetle Bioassay. North Central Branch, Ento. Society of America.
267. Barger, J. H. and W. K. Hock. 1971. Distribution of Dutch Elm Disease and the Smaller European Elm Bark Beetle in the United States as of 1970. Plant Disease Reporter 55(3):271-273.
268. Barger, J. H., R. A. Cuthbert and N. H. Roberto. 1971. Assessment of Three Pre-cold Storage Preparations on the Feeding Response of *Scolytus multistriatus* and the Degradation of Dicortophas. J. Econ. Ent. 64:621-624, illus.
269. Barger, J. H. et al. 1973. Statistical Correlations Between GLC Assay and Smaller European Elm Bark Beetle Bioassay. Jour. Econ. Ent. 66:79-81.
270. Barker, R. J. 1958. Notes on some Ecological Effects of DDT Sprayed on Elms. Jour. Wildlife Mgr. 22:269-274.
271. Barratt, R. W. ¹⁹⁴⁶ Intraseasonal Advance of Disease to Evaluate Fungicides of Genetical Differences. Phytopath. 35:654.
272. Barrus, M. F. et al. 1931. Elm (*ulmus* sp.) Plant Disease Reporter Suppl. 81:134.
273. Bartels, J. M. and G. N. Lanier. 1975. Emergence and Mating in *Scolytus multistriatus* (Coleoptera: Scolytidae). Ann. Ent. Soc. Amer. 67(3): 365-370.
274. Bartlett. 1928. The European Elm Disease. F. A. Bartlett Tree Expert Co., Stamford Conn., Bulletin #1.
275. Bavendamm, W. 1934. Kurpfuscher in Pflanzenschutz. (Ulmenheil). (Quacks in Plant Diseases. Elm Cures). Mitt. Deut. Dendrol. Ges. 46:175-6.
276. Baxter, D. V. 1943. Forest Pathology in Forest Practice. John Wiley and Sons, New York.
277. Beattie, R. K. 1931. Look for the Dutch Elm Disease. Blister Rust News 15:114.
278. Beattie, R. K. 1931. The Threat of the Dutch Elm Disease. Amer. Forests 37:489.

279. Beattie, R. K. 1932. Dutch Elm Disease Survey Indicates This Disease Not Widespread in This Country. U.S. Dept. Agr. Yearbook 1932 (for 1931):178-81 Illus.
280. Beattie, R. K. 1932. The Dutch Elm Disease. Plant Disease Reporter. 16:125.
281. Beattie, R. K. 1932. Susceptibility of American Elms to the Dutch Elm Disease. Plant Disease Reporter 16:146-147.
282. Beattie, R. K. 1933. How the Dutch Elm Disease Reached America. Nat. Shade Tree Conf. 9:101-105.
283. Beattie, R. K. 1933. Elm Disease Entered America Under Bark of Veneer Logs. Sci. News Letter 24(649):179.
284. Beattie, R. K. 1933. Present Status of the Elm Disease. Forest Worker 9(4):13.
285. Beattie, R. K. 1933. Dutch Elm Disease Spreads to New York State. Blister Rust News 17(8):136 (Processed).
286. Beattie, R. K. 1933. Dutch Elm Disease in New York. Amer. Nurseryman 58(5):58-59.
287. Beattie, R. K. 1933. The Dutch Elm Disease in New Jersey. The Shade Tree 6(7):2-3.
288. Beattie, R. K. 1933. The Dutch Elm Disease. Plant Disease Reporter 17:167.
289. Beattie, R. K. 1933. Disease Threatening Ornamental and Forest Trees. Jour. Econ. Ent. 26(3):621-624.
290. Beattie, R. K. 1933. Dutch Elm Disease. The Davey Bull. 21:6-7, July 29, 1933.
291. Beattie, R. K. 1934. The New Outbreak of the Dutch Elm Disease. Jour. Econ. Ent. 27:569-572.
292. Beattie, R. K. 1934. Dutch Elm Disease Found at Norfolk, Virginia. Plant Disease Reporter 18:191.
293. Beattie, R. K. 1934. Dutch Elm Disease in Indiana. Plant Disease Reporter 18:166.
294. Beattie, R. K. 1934. Advances in Our Knowledge of the Dutch Elm Disease. Nat. Shade Tree Conf. 10:76-78.

295. Beattie, R. K. 1934. Dutch Elm Disease Now Serious Around New York. Entered Country in Logs. U.S. Dept. Agr. Yearbook 1934:188-190.
296. Beattie, R. K. 1935. Research During 1934 on *Ceratostomella ulmi*, the Cause of Dutch Elm Disease. Jour. Econ. Ent. 28:528-531.
297. Beattie, R. K. 1936. Dutch Elm Disease in Europe. Phytopath. 27:122, (abs.), Feb. 1937. [Prepr: 1936.]
298. Beattie, R. K. 1937. The Dutch Elm Disease in Europe. American Forests 43:159-161.
299. Beattie, R. K. and G. F. Fravatt. 1933. Dutch Elm Disease, *Graphium ulmi*. Plant Disease Reporter Suppl. 85:61.
300. Beattie, R. K. and A. F. Verrall. 1935. The Entry and Movement of Elm Burl Logs. Plant Disease Reporter 19:11-14.
301. Beaver, R. A. 1967. Notes on the Biology of the Parasitic Mite *Pyemotes scolyti* Oud. (Acari: Pyemotidae). The Entomologist 100:9-12.
302. Beaver, R. A. 1967. The Biology and Immature Stages of *Entodon lucogramma* (Ratzeburg) (Hymenoptera: Eulophidae), a Parasite of Bark Beetles. Proc. Roy. Ent. Soc. London (A), 41(1-3):37-4).
303. Beaver, R. A. 1967. Hymenoptera Associated with Elm Bark Beetles in Wytham Wood, Berks. Trans. Soc. Brit. Ent. 17(6):141-50.
304. Becker, K. 1931. Ulmensterben Uberall. (The Elm Disease Everywhere). Prakt. Ratgeb. Obst-u Gartenb. 46:525 Illus.
305. Becker, W. B. 1935. Evidence of European Elm Bark Beetle Found in Western Mass. Jour. Econ. Ent. 28:833.
306. Becker, W. B. 1935. Some Observations on the Overwintering Habits of The American Elm Bark Beetle, *Hylurgopinus rufipes* Eichh. Jour. Econ. Ent. 28:1061-65.
307. Becker, W. B. 1936. Insects Concerned in the Dispersal of Dutch Elm Disease. Mass. Agri. Exp. Sta. Bull. 327 (Annual Report 1935):50-1.
308. Becker, W. B. 1937. Some Notes on the Tunneling Habits of *Hylurgopinus rufipes* Eichh. J. Econ. Ent. 30:375.
309. Becker, W. B. 1937. Some Observation on the Larvae Instars of *Hylurgopinus rufipes* in Massachusetts. (Unpublished) Fourteenth Conf. of Connecticut Entomologists (New Haven). 1937.

310. Becker, W. B. 1950. Sprays to Prevent Scolytid Infestation of Elm Logs. Mass. Agr. Expt. Sta. Bu 1. 459:47.
311. Becker, W. B. 1956. Seasonal Control of Dutch Elm Disease and Insects Pest of Elms in Massachusetts. Trees Mag. 16(4): 8, 9, 18, 19.
312. Becker, W. B. and W. E. Tomlinson. 1938. Distribution of Elm Bark Beetles in Massachusetts. Jour. Econ. Ent. 31:323.
313. Becker, W. B. and R. A. Mankowsky. 1965. Twig Feeding by the Smaller European Elm Bark Beetle on Different Kinds of Trees. Jour. Econ. Ent. 58:132-4.
314. Beckman, C. H. 1956. Production of Pectinase, Cellulases, and Growth Promoting Substances by *Ceratostomella ulmi*. Phytopath. 46:605-609.
315. Beckman, C. H. 1958. Growth Inhibition as a Mechanism in Dutch Elm Disease Therapy. Phytopath. 48:172-176.
316. Beckman, C. H. 1959. Dutch Elm Disease Control With Polychlorobenzoic Acid. Phytopath. 49:227 (Abstr.).
317. Beckman, C. H. 1964. Host Responses to Vascular Infection. Ann. Rev. Phytopath. 2:231-252.
318. Beckman, C. H. 1966. Cell Irritability and Localization of Vascular Infection in Plants. Phytopath. 56:821-824.
319. Beckman, C. H. and F. L. Howard. 1957. Chemical Inhibition of Springwood Development in Relation to Infection and Symptoms of the Dutch Elm Disease. Phytopath. 47:3 (Abstr.).
320. Beekman, H. and F. W. Malsch. 1931. Bestrijding van de Iepenziekte. (Fighting the Elm Disease). Nederl. Boschb.-Tijdschr. 4:392-3.
321. Benedict, W. G. 1969. Anatomy of Young Branches of American Elms Naturally Infected With *Ceratocystis ulmi*. Phytopath. 59:1200-1202.
322. Betrem, J. G. 1929. (The Elm Disease and the Elm Sap Beetles) Tijdschr. Plantzen. 35:273-288.
323. Betrem, J. G. 1930. Das Ulmensterben und der Ulmensplintkafer. (The Elm Disease and the Elm Sapwood Beetles). Mitt. Deut. Dendr. Gesell. 43:335-336.
324. Betrem, J. G. 1930. De Iepenziekete en de Iepensplintkevers. Vergsl. Med. Plantenz. Dienst. Wageningen. 60:1-17. f:1-10. Jan. 1930.

325. Biddle, R. G. 1973. Continuing the DED Fight - Two Reports on Benomyl. Partly Infected Trees Saved. *Gardeners Chronicle* 173(4);25,27-29.
326. Biehn, W. L. 1971. Prophylactic Action of Benomyl Against Dutch Elm Disease. *Plant Disease Reporter* 55(2):179.
327. Biehn, W. L. 1973. Long-term Protective Action of Benomyl Soil Treatment Against Dutch Elm Disease. *Plant Disease Reporter* 57(1):35-37.
328. Biehn, W. L. and A. E. Dimond. 1970. Effect of Carbon Sources on the Production of Polygalacturonase by *Ceratocystis ulmi*. *Phytopath.* 60:1284 (Abstr.).
329. Biehn, W. L. and A. E. Dimond. 1970. Protective Action of Benomyl Against Dutch Elm Disease. (Abstr.) *Phytopath.* 60:571.
330. Bingham, R. T. et al. 1971. Disease Resistance in Forest Trees. *Ann. Review of Phytopath.* 9:433-452.
331. Biorge, Ph. 1927. La Maladie des Ormes. (The Elm Disease). *Bull. Soc. Centr. For. Belgique* 30 (Ann. 34):49:64, 97-112, Illus., Bibl. Feb./Mar. 1927.
332. Black, W. M. and D. Neely. 1974. Inhibition of Colonization by *Ceratocystis ulmi* in Benomyl-treated Elms. *Plant Disease Reporter* 58(6):511-513.
333. Blackman, M. W. 1933. Insect Vectors of the Dutch Elm Disease. *USDA Bur. Entom. Leaflet* 4 pp., Illus.
334. Blackman, M. W. 1934. A Revisional Study of the Genus *Scolytus* Geoffroy (*Eccoptogaster* Herbst) in North America. *USDA Tech. Bull.* 431:31 pp.
335. Bollen, G. J. 1972. A Comparison of the In Vitro Antifungal Spectra of Thiophanates and Benomyl. *Neth. Jour. Plant Path.* 78:55-64.
336. Borden, J. H. and E. H. Stokkink. 1971. Secondary Attraction in the Scolytidae: an Annotated Bibliography. *Can. Dept. Fish. and For. Info. Rep.* BC-X-57.
337. Borg, T. K. and D. M. Norris. 1969. Feeding Responses by *Hylurgopinus rufipes* to Combined Chemical and Physical Stimuli. *Ann. Ent. Soc. Am.* 62:730-733.
338. Borg, T. K. and D. M. Norris. 1971. Penetration of H³ - catechol, a Feeding Stimulant, into Chemoreceptor Sensilla of *Scolytus Multistriatus* (Coleoptera: Scolytidae). *Ann. Ent. Soc. Am.* 64:544-547.

339. Bos, H. 1924. Het af-en Insterven van Bomen. (The Die-back of Trees). Tidjschr. Plantenz. 30:132-42.
340. Bos, J. R. 1924. Beknopte Aanteekeningen op Plantenziektenkundig Gebied. (Notes in the Plant Disease Field). Tidjschr. Plantenz. 30:65-80.
341. Boschini, G. 1934. Brevi Considerazioni Intorno Alla Moria Degli Olmi. (Brief Consideration of the Elm Disease). Romagna Agr. Zootecn. 28:151-58.
342. Boudru, M. 1933. (Notes on the Biology of *Ceratostomella ulmi* (Schwarz) Busiman, the Agent of Parasitic Tylosis of the Elm). Bull. Inst. Agron, et de Stat. de Rech, de Gembloux 2:310-346.
343. Boudru, M. 1935. (The Elm Disease in Belgium). Bull. Soc. For. Belg. 42:508-522.
344. Boyce, J. S. 1938. Forest Pathology. McGraw-Hill Book Co., New York.
345. Boyce, J. S. et al. 1942. Report of Northeastern Committee on Dutch Elm Disease. Mass. For. and Park Assoc.
346. Brasier, C. M. and J. N. Gibbs. 1973. Origin of the Dutch Elm Disease Epidemic in Britain. Nature 242:607-609.
347. Brasier, C. M. and J. N. Gibbs. 1973. Variation in *Ceratocystis ulmi*. Proc. IUFRO Conf. Sept. pp.53-76.
348. Brasier, C. M. and J. N. Gibbs. 1975. Highly Fertile Form of the Aggressive Strain of *Ceratocystis ulmi*. Nature 257(5522):128-131.
349. Brasier, C. M. and J. N. Gibbs. 1975. MBC Tolerance in Aggressive and Nonaggressive Isolate of *Ceratocystis ulmi*. Ann. Appl. Biol. 80 (2):231-235.
350. Brener, W. D. and C. H. Beckman. 1968. A Mechanism of Enhanced Resistance to *Ceratocystis ulmi* in American Elms Treated With Sodium Trichlorophenylacetate. Phytopath. 58:555-561.
351. Bretz, T. W. 1949. Leaf-bud Cuttings as a Means of Propagating Disease-resistant Elms. Plant Disease Reporter 33:434-436.
352. Bretz, T. W. 1950. Seed Transmission of the Elm Mosaic Virus. Phytopath. 40:3 (Abstr.).
353. Bretz, T. W. and R. V. Swingle. 1950. Experimental Propagation of Disease-resistant Elm Selections by Vegetative Cuttings. Phytopath. 40:4 (Abstr.).

354. Bretz, T. W. and R. V. Swingle. 1950. Propagation of Disease-resistant Elms, Amer. Nurseryman 92:(4):7-9, 65-66.
355. Bretz, T. W. et al. 1946. Some Recent Observations on Elm Phloem Necrosis and the Dutch Elm Disease. Nat. Shade Tree Conf. Proc. 21:25-28.
356. Brewer, E. G. 1941. The Fight for Elms. Review of Progress Made in the Campaign Against the Dutch Elm Disease. American Forests 48:22-25.
357. Bridgemon, G. H. 1970. Dutch Elm Disease in Wyoming. Plant Dis. Reporter 54:547.
358. Brill, O. F. 1930. Vorschage zur Bekämpfung des Ulmensterbens. (Suggestions for the Control of the Die-back of Elms). Gartenwelt. 4(48):658-660:690-691.
359. Brill, O. 1931. Neue Beobachtungen über die Schuld des Ulmensplintkafers. (New Observations on the Complicity of the Elm Sap Beetle). Gartenwelt. 35(9):114-115.
360. Brill, O. 1931. Rettung Graphiumkranker Ulmen Durch Ruckschnitt. (Saving Graphium-diseased Trees by Back Cutting). Gartenwelt. 35:650 Illus.
361. Brill, O. 1932. Nochmals: Ruckschnitt Gegen die Ulmenkrankheit. (Once More: Back-cutting as a Remedy for the Elm Disease). Gartenwelt. 36:97-8.
362. Britton, W. E. 1934. Connecticut State Entomologist, Thirty-third Report, Conn. Agr. Exp. Sta. Bull. 360:386-486.
363. Britton, W. E. 1935. Another Probable Carrier of the Dutch Elm Disease. Conn. Agr. Exp. Sta. Bull. 368:256.
364. Britton, W. E. 1935. Connecticut State Entomologist, Thirty-fourth Report. Conn. Agr. Exp. Sta. Bull. 368:147-262, see pp. 256-7, Mar. 1935.
365. Britton, W. E. and R. B. Friend. 1935. Insect Pests of Elms in Connecticut. Conn. Agr. Exp. Sta. Bulletin 369:263-307.
366. Broekhuizen, S. 1929. (Wound Reaction of Wood, the Development of Tyloses and Wound Gum Especially in Relation to the Elm Disease). Thesis Univ. of Utrecht. 78 pp.

367. Bromley, S. W. 1950. Tests on Elm *Scolytus* 1949. Jour. Econ. Ent. 43:397-398.
368. Brotzman, H. G. and R. J. Campana. 1968. Viability In Vitro of the Smallest Spores of *Ceratocystis ulmi* Following Centrifugation and Microfiltration. Phytopath. 58:398.
369. Brown, A. W. A. 1963 Problems in Chemical Control. Unpublished Mimeo Report to 1st. Symposium on Shade Trees, Toronto.
370. Brown, H. D., DR. R. Kucera and P. H. Peacher. 1969. Dutch Elm Disease Detected in Alabama. Plant Disease Reporter 53:307.
371. Brown, L. R. 1965. Seasonal Development of the Smaller European Elm Bark Beetle in Southern California. J. Econ. Ent. 58:176-177.
372. Brown, M. F. 1963. A Method for Extracting Conidia From Elm Wood. Abstr. in Phytopath. 53:347.
373. Brown, M. F., R. J. Campana and M. A. Rosinki. 1963. Downward Movement of Conidia of *Ceratocystis ulmi* From Terminal Twigs of Elm. Abstr. in Phytopath. 53:871.
374. Brussof, A. 1925. Die Hollandische Ulmenkrankheit - eine Bakteriosis. (The Dutch Elm Disease - a Bacteriosis). Cbl. Bakt. Abt. II 63:256-257.
375. Brussof, A. 1926. Das Ubergreifen des *Micrococcus ulmi* auf Ahorne und Linden. (The Spread of *** to Maples and Lindens). Ztschr. Pflanzenkr. 36:269-74.
376. Brussof, A. 1926. Das Ubergreifen des *Micrococcus ulmi* auf Rotbuchen und Kanadische Pappeln. (The Spread of *** to Copper Beech and Canadian Poplar). Ztschr. Pflanzenkr. 36:351-5.
377. Brussof, A. 1926. Das Ubergreifen des Mikroben der Ulmenkrankheit auf Andere Baumarten. (The Spread of the Elm Disease Bacterium to Other Kinds of Trees). Forstschr. Landu. 1:753.
378. Brussof, A. 1926. Das Ulmensterben. (The Elm Disease). Die Umschau 30:950-4 Illus.
379. Brussof, A. 1927. Ueber das Durch Bakterien Verursachte Sterben der Ulmen and Anderer Laubbaume. (On the Bacteria Causing Death of Elms and Other Shade Trees). Mitt. Deut. Dendrol. Ges. 38:244-51, Illus.

380. Brussof, A. 1927. Die Ulmenkrankheit und ihr Übergreifen auf Rotbuchen und Andere Baumarten. (The Elm Disease and its Spread to Copper Beech and Other Trees.) Ztschr. Forst. - u. Jagdw. 59:147-52, Mar. 1927.
381. Brussof, A. 1928. Ueber die Ursache des Ulmensterbens Eine Erwiderung auf den Artikel von Dr. C. Strapp. (On the Cause of the Elm Dieback. A Reply to the Article of Dr. C. Strapp). Mitt. Deut. Dendrol. Ges. 40:292-7.
382. Buchanan, W. D. 1940a. *Scolytus sulcatus* Le C. Transmits Dutch Elm Disease Fungus Under Controlled Conditions. J. Econ. Ent. 33:250-251.
383. Buchanan, W. D. 1940b. Ambrosia Beetle, *xylosandrus germanus* Transmits Dutch Elm Disease Under Controlled Conditions. J. Econ. Ent. 33:819-820.
384. Buchanan, W. D. 1941. Experiments With an Ambrosia Beetle, *Xylosandrus germanus* (Blfd.). J. Econ. Ent. 34:367-369.
385. Buchanan, W. D., and C. May, 1942. Technique for Artificially Feeding *Scolytus multistriatus* and *Saperdu tridentata* Spores of *Ceratostomella ulmi* and Other Substances. Phytopath. 32:95-97.
386. Buchanan, W. D. and S. J. Smuker. 1942. Reaction of *Ceratostomella ulmi* in Occluded Infections and Contamination of *Scolytus multistriatus*. J. Econ. Ent. 35:178-180.
387. Buchanan, W. D., C. May and J. M. Walter. 1935. *Ceratostomella* (*Graphium*) *ulmi*, the Cause of the Dutch Elm Disease, Transmitted by *Scolytus multistriatus*. J. Econ. Ent. 28:138 (Abstr.).
388. Buchholz, A. B. 1943. Control of Dutch Elm Disease. In Report of Bureau of Plant Industry. N.Y. State Dept. Agr. and Markets Ann. Rpt. 1943: 137-143.
389. Buisman, C. J. 1928. De Oorzaak van de Iepenziekte. Tijdschr. d. Nederl. Heid. Afl. 10(1928):1-7.
390. Buisman, C. J. 1928. De Oorzaak van de Iepenziekte. (The Cause of the Elm Disease.) Tijdschr. Nederl. Heidemaatsch. 40:338-45, Germ. Summary, Oct., 1928.
391. Buisman, C. J. 1929. Onderzoek Naar de Oorzaak van de Iepenziekte. De Iepenziekte:13-78.
392. Buisman, C. J. 1930. The Dutch Elm Disease. Phytopath. 20:111 (Abstr.).

393. Buisman, C. J. 1931. Overzicht van de Soorten van Iepen, in Verband mit het Iepenziekteonderzoek. (Survey of Elm Varieties in Connection With the Elm Disease Investigation). Tijdschr. Plantenz. 37:111-116 Illus.
394. Buisman, C. J. 1931. Uebersicht Uber die Ulmenarten in Bezug auf den Kampf Gegen die Ulmenkrankheit. (Survey of Elm Species in Connection With the Campaign Against the Elm Disease). Aguv. Bot. 13:459-64.
395. Buisman, C. J. 1932. (Report of the Phytopathological Investigations on the Elm Disease Conducted in the "Willie Commeline Scholten" Laboratory during 1931). Tijdschr. Plantenz. 38:17-36.
396. Buisman, C. J. 1932. Das Grosse Ulmensterben. (The Serious Elm Disease). Deut. Forst. Ztg. 47:141-2.
397. Buisman, C. J. 1932. *Ceratostomella ulmi*, de Geslachtelyke Vorm van *Graphium ulmi* Schwarz. Tijdschr. Plziekt. 38:1-5.
398. Buisman, C. J. 1932. Over het Voorkomen van *Ceratostomella ulmi* Schwarz. Buisman in de Naturer. Tijdschr. Plziekt. 38:204-4.
399. Buisman, C. J. 1932. *Ceratostomella ulmi* de Geslachtel 'Jke Vorm van *Graphium ulmi* Schwarz. Neth. Jour. Plant Path. 37:111-116.
400. Buisman, C. J. 1933. Proven over Waterverdamping bij Bladeren van Verschillende Iepensoorten. (Experiments Concerning Transpiration by the Leaves of Various Elm Spp.). Tijdschr. Plantenz. 39:38-41.
401. Buisman, C. J. 1933. Iepencultuur en Iepenziekte in Italie. (Elm Cultivation and the Elm Disease in Italy). Nederl. Boschb.-Tijdschr. 6:147-52, Illustrated.
402. Buisman, C. J. 1933. Ueber die Biologie und den Parasitismus der Gattung *Ceratostomella* Sacc. (On the Biolgy and Parasitism of the Genus***). Phytopath. Ztschr. 6:429-39.
403. Buisman, C. J. 1933. De Iepenziekte. (The Elm Disease). Tijdschr. Nederl. Heidmaatsch. 45:219-37, Illus.
404. Buisman, C. J. 1933. Verslag van de Onderzoekingen Over de Iepenziekte, Verricht in het Phytopathologisch Laboratorium "Willie Commelin Scholten" to Baarn, Gedurende 1932. Reprint: Meded. Iepenziekten Comite No. 13:1-30 f. 1-2.
405. Buisman, C. J. 1934. Versalg van de Onderzoekingen Over de Iepenziekte, Verricht in het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn, Gedurende 1933. (Report of the Researches on the Elm Disease Made in the Laboratory *** at Baarn During 1933). Tijdschr. Plantenz. 40:65-87.

406. Buisman, C. J. 1934. De Iepen ziekte in Amerika. (The Elm Disease in America). Nederl. Boschb.-Tijdschr. 7:439-40.
407. Buisman, C. J. 1934. The Area of Distribution of the *Ceratostomella* (*Graphium*) Elm Disease. Meded. Phytopath. Labor. Willie Comm. Scholt., Baarn. 13:35-46, Bibl.
408. Buisman, C. J. 1935. Sensibilite de Diverses Especes et Varietes d'Orme a *Ceratostomella ulmi*. (Susceptibility of Different Species and Varieties of Elm to ****). Rev. Path. Veg. & Ent. Agr. 22(3):200-8.
409. Buisman, C. J. 1935. Verslag Over de Onderzoekingen Betreffende de Iepen ziekte; Verricht in Het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn, Gedurende 1934. (Report on the Elm Disease Investigations Carried on at the Phytopathological Lab. **** at Baarn in 1934). Tijdschr. Plantenz. 41:104-20, Illus.
410. Buisman, C. J. 1935. Het Iepen ziekte-probleem in Italie. (The Elm Disease Problem in Italy, Nederl. Boschb.-Tijdschr. 8:179-80.
411. Buisman, C. J. 1936. (Report on the Investigations Relating to the Elm Disease Conducted in the Willie Commelin Scholten Phutopathological Laboratory, Baarn, During 1935). Tijdschr. Plantenz. 42:21-44.
412. Buisman, C. J. 1936. De Resistente Iep. Nr. 24. (The Resistant Elm No. 24). Tijdschr. Nederl. Heidemaatsch. 48:73-6.
413. Buisman, C. J. 1936. Inoculaties met Behulp van Iepenspintkevers. (Innoculations With the Help of the Elm Bark Beetles). Meded. van het Iepen ziekten-Comite; #22. 3-17.
414. Burdekin, D. A. and J. N. Gibbs. 1972. Dutch Elm Disease - Recurrence and Recovery in Britain. Nature 240:306.
415. Burdekin, D. A., J. N. Gibbs and A. F. Mitchell. 1972. The Control of Dutch Elm Disease. HMSO-Forest Commission Leaflet. 54-6 p.
416. Burger, F. W. 1930. Het Overbrengen der Iepen ziekte. (On the Spread of the Elm Disease). Nederl. Boschb.-Tijdschr. 3:50-4.
417. Burger, F. W. 1938. Iepen sterfte in Nederland. Tijdschr. Plziekt. 44(4):177-207.
418. Burkholder, P. R. and I. McVeigh. 1942. Pyridoxine as a Growth Factor for *Graphium*. Science 95:127-128.

419. Burton, W. E. 1934. Watch Your Elms. Country Gentlemen 104:7, 72, Illus.
420. Bushing, R. W. 1965. A Synoptic List of the Parasites of Scolytidae (Coleoptera) in North America North of Mexico. Can. Ent. 97:449-92.
421. Butcher, J. W. et al. 1966. Investigations on Control of Dutch Elm Disease Vectors in Michigan. Dept. Ent., Michigan State Univ. 74 p.
422. Campana, R. 1958. Elms Susceptible to Dutch Elm Disease. Trees Mag. Ohio 19(1):6.
423. Campana, R. 1960. Septic Culture of *Ceratocystis ulmi* on Elm Wood. Plant Disease Reporter 44(12):908-911.
424. Campana, R. 1967. Spore Movement and Limited Symptom Development of Dutch Elm Disease in Small Elm Stems. Midwestern Chapt. Int. Shade Tree Conf. Proc. 22:47-52.
425. Campana, R. 1968. Dutch Elm Disease; a Matter of Priorities. Weeds Trees and Turf 8(7):6-37.
426. Campana, R. 1971. Influence of Gamma Radiation on Vessel Development and Spore Movement in American Elm. Phytopath. 61(8):887 (Abstr.).
427. Campana, R. 1974. Prophylactic and Therapeutic Effect of Methly 2 - Benzimidazole - Carbamate Hydrochloride (MBC-HCL) Against Dutch Elm Disease in Nursery Elms. M.S. Thesis, Univ. of Maine.
428. Campana, R. 1974. Comparative Size, Number and Distributions of Vessels in Roots and Stems of American Elm as Factors in Recurrence of Dutch Elm Disease. Abstr. Proc. Am. Phytopath. Soc. 1:30-31.
429. Campana, R. and H. G. Brotzman. 1967. Restricted Development of Dutch Elm Disease in Small Elm Stems. Phytopath. 57:338 (Abstr.).
430. Campana, R. and J. C. Carter. 1957. The Current Status of Dutch Elm Disease in Illinois. Plant Dis. Reporter 41(7):636-39.
431. Campana, R. and F. Hyland. 1970. Relation of Foliar Development to Maturation of Elm Vessels and Susceptibility to Dutch Elm Disease. Proc. Internat. Symposium on Dutch Elm Disease 1968. Iowa State Univ. Press, Ames, Iowa.
432. Campana, R. J. and E. J. King. 1974. Prophylatic and Therapeutic Effect of Methyl 2-Benzimidazole-Carbamate Hydrochloride (MBC-HCL) Against Dutch Elm Disease in Nursery Elms. Abstr. Proc. Am. Phytopath Soc. 1:31.

433. Campana, R. and A. L. Pratt. 1972. Inhibition of Movement of *Ceratocystis ulmi* in Elm Stems by Wounding. *Phytopath.* 2(7):750 (Abstr.).
434. Campana, R. and M. A. Rosinki. 1961. A Simplified Method for Culture of *Ceratocystis ulmi*. *Phytopath.* 51:575 (Abstr.).
435. Campana, R., R. Ring and A. Prat. 1971. Comparative Downward Movement of Spores of *Ceratocystis ulmi* in Diffuse and Ring-porous hardwoods. *Phytopath.* 71(2):127 (Abstr.).
436. Campana, R. J. et al. 1972. Development and Control of Dutch Elm Disease. Ann. Progress Report Project NE-25.
437. Canada Dept. of Agriculture. 1958. Dutch Elm Disease. C.D.A. Forest Biology Div., Publication 1010.
438. Caroselli, N. E. and A. W. Feldman. 1951a. Dutch Elm Disease Chemotherapy With Carolate and Related Formulations. *Phytopath.* 41:6.
439. Caroselli, N. E. and A. W. Feldman. 1951b. Dutch Elm Disease in Young Seedlings. *Phytopath.* 41:46-51.
440. Carter, J. C. 1935. A Report on Tests of Fungicides for the Control of Elm Diseases in Nurseries. Ill. Nat. Hist. Surv. Div. Biol. Notes 4:7 pp.
441. Carter, J. C. 1936. *Cytosporina ludibunda* on American Elm. *Phytopath.* 26:805-806.
442. Carter, J. C. 1936. *Thyrostroma compactum* on *Ulmus pumila*. *Phytopath.* 26:801-804.
443. Carter, J. C. 1945. Wetwood of Elms. Ill. Nat. Hist. Surv. Bull. 23.
444. Carter, J. C. 1947. *Tubereularia* Canker and Die-back of Siberian Elm (*Ulmus pumila* L.) *Phytopath.* 37:243-246.
445. Carter, J. C. 1955. Illinois Trees: Their Diseases. Ill. Nat. Hist. Survey Circular 46:99 pp.
446. Carter, J. C. 1962. Dutch Elm Disease in Illinois. Illinois Natural History Sruvey, Urbana, Illinois. 10 p.

447. Carter, J. C. 1963. A Basic Approach to the Dutch Elm Disease Control. Internatl. Shade Tree Conf. Proc. 39:122-131.
448. Carter, J. C. 1964. Dutch Elm Disease in Illinois. Illinois Natural History Survey Pamphlet. 10 p. Second Printing With Revisions.
449. Carter, J. C. 1964. A Basic Approach to the Dutch Elm Disease Problem. Proc. 39th International Shade Tree Conf. p. 122-131.
450. Carter, J. C. 1964. The Wetwood Disease of Elm. Ill. Nat. His. Survey Circular 50 19 pp.
451. Carter, J. C. 1966. What's Happening in Dutch Elm Disease Control. Illinois Custom Spray Operators Training School. 18:49-50.
452. Carter, J. C. 1966. Dutch Elm Disease in Illinois. Illinois Natural History Survey Pamphlet. 10 p. Third Printing with Alterations.
453. Carter, J. C. 1966. Dutch Elm Disease Control. Illinois State Florists Association Bulletin 275:3-5.
454. Carter, J. C. 1967. Dutch Elm Disease Control. Illinois State Nurserymen's Association Newsletter 97:3-4.
455. Carter, J. C. 1967. Dutch Elm Disease in Illinois. Illinois Natural History Survey Circ. 53:1-19.
456. Carter, J. C. and L. R. Carter, 1974. An Urban Epiphytotic of Phloem Necrosis and Dutch Elm Disease, 1944-1972. Ill. Nat. His. Survey Bulletin 31(4):113-144.
457. Casagrande, F. and G. B. Ouellette. 1971. A Technique to Study the Developments of Soft Rot Fungi and its Application to *Ceratocystis ulmi*. Can. Jour. Bot. 49:155-159.
458. Cecconi, G. 1932. La Moria Degli Olmi (Die-back of Elms). Riv. Agr. (Rome). 28:478-80.
459. Cecconi, G. 1932. Per la Salvezza dei Nostri Olmi. (For the Salvation of Our Elm.) Riv. Agr. (Rome) 28:478-80, 1932.
460. Chamberlain, J. E. 1934. To Arms for the American Elm! Amer. For. 40:195-99, 230-32, Illus.
461. Chamberlin, W. J. 1939. The Bark and Timber Beetles of North America. Ore. State Coll. Coop. Assoc. 513p.

462. Chambers, E. L. 1931. Biennial Report - 1929-30. Wisc. Dept. Agr. and Markets Bulletin. 115:68 pp.
463. Chambers, E. L. and Staff. 1958. Dutch Elm Disease. Wisc. State Dept. of Agr. Special Bulletin. 62, Revised.
464. Chambers, E. L. and Staff. 1961. Dutch Elm Disease and its Control. Wisc. State Dept. of Agr., Special Bulletin. 62, Revised.
465. Chapman, J. W. 1910. The Introduction of a European Scolytid (the Smaller Elm Bark-Beetle, *Scolytus multistriatus* Marsh) into Massachusetts. Psyche 17:63-8, Illus.
466. Chapman, J. W. 1911. The Leopard Moth and Other Insects Injurious to Shade Trees in the Vicinity of Boston. Bussey Inst. Publ. Contr. No. 48 from Ent. Lab., 3-51, 1911.
467. Chapman, J. 1967. Response Behavior of Scolytid Beetles and Odom Meterology. Can. Ent. 99:1132-37.
468. Chester, K. S. 1947. Nature and Prevention of Plant Diseases. The Blakiston Company, Toronto, 1941.
469. Claassen, P. W. et al. 1935. The Dutch Elm Disease. Cornell Agr. Exp. Sta. Ann. Rept. 48:96.
470. Claflin, L. E. and O. J. Dooling. 1973. Dutch Elm Disease in Montana. Plant Disease Reporter 57(8):701.
471. Clapham, A. R., T. G. Tutin and E. F. Warburg. 1952. Flora of the British Isles. Cambridge University Press.
472. Clapper, R. B. 1949. Breeding and Selecting Pest-resistant Trees. USDA Agr. Yearbook 1949. pp. 465-471.
473. Clark, M. A. and R. K. Beattie. 1935. Misleading Unproven Reports of *Graphium ulmi* on Burbank Plum. Plant Dis. Reporter 19:148-50.
474. Claydon, N. et al. 1974. Phenolic Metabolic Products of *Ceratocystis ulmi*. Chem. and Ind. 8:344-345.
475. Claydon, N. et al. 1974. Phenolic Metabolites of *Ceratocystis ulmi*. Phytochemistry 13(11):2567-2571.
476. Clemons, G. P. and H. D. Sisler. 1969. Formation of a Fungitoxic Derivative from Benlate. Phytopath. 59:705-706.
477. Clinton, G. P. 1934. Dutch Elm Disease, *Graphium ulmi*. Conn. Agr. Exp. Sta. Bull. 358:305-06.

478. Clinton, G. P. and F. A. McCormick. 1935. The Dutch Elm Disease, *Graphium ulmi*, in Connecticut. Science 81:68-70.
479. Clinto, G. P. and F. A. McCormick. 1936. The Dutch Elm Disease, *Graphium ulmi* Conn. Agr. Exp. Sta. Bull. (New Haven). 389:701-752.
480. Collingwood, G. H. 1937. Forestry in Congress. Amer. For. 41:92, 190-1; 42:40, 91, 184, 332-4; 43:43, 90, 202, 254, 308, Feb. and Apr., 1935, Jan., Feb., Apr., and July, 1936, Jan., Feb., Apr., May and June, 1937.
481. Collingwood, G. H. 1937. A Billion Elms at Bay. Amer. For. 43:211-215, 264-65, Illus.
482. Collins, C. W. 1935. Insect Vectors of the Dutch Elm Disease Caused by the Fungus *Ceratostomella ulmi* (Schwarz) Buisman. Nat. Shade Tree Conf. 11:127-32.
483. Collins, C. W. 1938. Two Elm Scolytids in Relation to Areas Infected With the Dutch Elm Disease Fungus. Jour. Econ. Ent. 31:192-195.
484. Collins, C. W. 1941. Studies of Elm Insects Associated With Dutch Elm Disease Fungus. Jour. Econ. Ent. 34:369-372.
485. Collins, C. W., W. D. Buchanan, R. R. Whitten and C. H. Hoffman. 1936. Bark Beetles and Other Possible Insect Vectors of the Dutch Elm Disease, *Ceratostomella ulmi*. Jour. Econ. Ent. 29:169-176.
486. Collins, D. C. 1940. The Dutch Elm Disease. Rpt. N.Y. Agr. Expt. Sta., (Cornell) 52, 1939; 136, 1940.
487. Collins, D. J. 1938. Feeding Habits of *Scolytus multistriatus* Marsham, With Reference to the Dutch Elm Disease. Jour. Econ. Ent. 31:196-200.
488. Collins, D. J., K. G. Parker and H. Dietrich. 1940. Uninfected Elm Wood as a Source of the Bark Beetle (*Scolytus multistriatus* Marsh.) Carrying the Dutch Elm Disease Pathogen. N.Y. (Cornell) Agr. Exp. Sta. Bulletin. 740.
489. Collins, P. E. 1955. Chinkota Elm. S. Dak. Farm and Home Res. 7:14-27.
490. Collins, P. E. 1968. Hybridization Studies in the Genus *Ulmus*. Doctoral Thesis. 84 p. University Minnesota.
491. Connecticut Agr. Exp. Sta. 1931. Report of the Director for the Year Ending Oct. 31, 1930. Connecticut Agr. Exp. Bulletin 322:109-150.

492. Connecticut Agr. Exp. Sta. 1934. Report of the Director for the Year. Ending Oct. 31, 1933. Conn. Agr. Exp. Sta. Bulletin 357:117-148.
493. Connecticut Agr. Exp. Sta. 1934. Connecticut (New Haven) Station Notes. E.S.R. 71:734, Nov. 1934.
494. Connecticut Agr. Exp. Sta. 1935. Dutch Elm Disease (*Graphium ulmi*) in Conn. Conn. Agr. Exp. Sta. Circ. 106:8 pp.
495. Connecticut Forest and Park Assoc. 1935. Our Elms Threatened. Conn. Forest & Park Assoc. Leaflet 26:4 pp. Jan., 1935.
496. Connecticut Agr. Exp. Sta. 1945. Report of the Director for the Year Ending Oct. 31, 1944. Conn. Agr. Exp. Sta. Bull. 484:68-71.
497. Conners, I. L. 1937. Sixteenth Annual Report of the Canadian Plant Disease Survey, 1936. 11:88 pp.
498. Conners, I. L. 1945. Twenty-fourth Annual Report of the Canadian Plant Disease Survey, 1944. 18:122 pp.
499. Connola, D. P., D. L. Collins and L. E. Hagmann. 1947. Log Treatments for Bark Beetle Control in Connection with the Dutch Elm Disease. Cornell Agr. Exp. Sta. Bull. 841.
500. Corneli, E. 1933. (Die-back of Elms by *Graphium ulmi*). Riv. Patol. Veg. 23:27-31.
501. Craig, Vernon. 1970. Preserving a Woodland Effect. Grounds Maint. 5(2):24-26, Dutch Elm Disease History College of Wooster, Wooster, Ohio.
502. Crane, J. L. and J. D. Schoknecht. 1973. Conidiogenesis in *Ceratocystis ulmi*, *Ceratocystis piceae*, and *Graphium penicillioides*. Amer. J. Bot. 60(4):346-354.
503. Creager, D. B. 1935. New Facts Concerning *Cephalosporium* Wilt of Elms. Jour. Arnold Arboret. 16:453-457.
504. Creager, D. B. 1937a. *Cephalosporium* Wilt of Elms. Proc. Nat. (U.S.) Shade Tree Conf. 1936 p. 140-144.
505. Creager, D. B. 1937b. The *Cephalosporium* Disease of Elms. Cont. Arnold Arb. #10, 91 pp.
506. Cusumano, R. D. and G. L. Wasser. 1965. A Survey of Practices in Regard to the Air Pollution Aspects of Dutch Elm Disease Eradication and its Coleopteran vector. *Scolytus multistriatus* and *Hylurgopinus rufipes*. J. Air. Poll. Control Ass. 15(5):230-234.

507. Cuthbert, R. A. and J. W. Peacock. 1975. Attraction of *Scolytus multistriatus* to Pheromone - baited Traps at Different Heights. Env. Ent. 4(6): 889-890.
508. Cuthbert, R. A., A. C. Lincoln. B. H. Kennedy and N. H. Roberto. 1970. Laboratory Assay of *Scolytus multistriatus* and *Dendrosoter protuberans* on DDT and Methoxychlor. J. Econ. Ent. 63(6):1889-1891.
509. Cuthbert, R. A. et al. 1975. An Estimate of the Effectiveness of Pheromone - baited Traps for the Suppression of *Scolytus multistriatus*. N.E. For. Exp. Sta.
510. Cuthbert, R. A. et al. 1975. Formulation and Application of Methoxychlor for Elm Bark Beetle Control. U.S.F.S. Res. Paper N.E. - 283.
511. Cuthbert, R. A. et al. 1975. Relative Importance of Root Grafts and Bark Beetles to the Spread of Dutch Elm Disease. U.S.D.A. For. Serv. Research Note - NE206. 1941.
512. Czaninski, Y. et al. 1975. Ultrastructure du Xyleme de l'Orme Atteint par le *Ceratocystis ulmi* (Buis.) C. Moreau. Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, D(280): 853-856.
513. Dalby, G. 1963. (unpublished) General Description of Dutch Elm Disease. 1st Symposium on Shade Trees, Toronto, 1963.
514. Dance, B. W. and D. F. Lynn. 1963. Ontario, Forest Disease Conditions. In Annual Report of the Forest Insect and Disease Survey, 1962. Dept. For., For. Ent. and Path. Branch, Ottawa. 1963.
515. Dance, B. W. and D. F. Lynn, 1964. Ontario, Forest Disease Conditions. In Annual Report of the Forest Insect and Disease Survey, 1963. Dept. For., For. Ent. and Path. Branch, Ottawa. 1964.
516. Dance, B. W., D. F. Lynn and L. H. Christie. 1965. Field Test With 2, 3, 6-Trichlorophenyl Acetic Acid to Control Dutch Elm Disease. Can. Dept. of For. Bi-mon Prog. Rpt. 21(3):1-2.
517. Dannenberg, P. 1932. Ulmensterben. (Elm Disease). Schlesischen Ges. f. Waterlandische Cultur (Breslau) Jahres-ber. 104(1931):140-50.
518. Davidson, A. G. 1958. Dutch Elm Disease Firmly Establis' ' : N Brunswick. Bi-Mon. Prog. Rep. Div. For Biol., Dep. Agric. Can. 14(5):1.
519. Davidson, A. G. 1959. Forest Disease Survey, Atlantic Provinces. In Ann. Rept. For. Insect and Disease Surv., For. Biol. Div. Canada Department of Agriculture, 1958. p. 26.
520. Davidson, A. G. (Complier). 1964. A Review of the Dutch Elm Disease. Bi-Mon. Prog. Rep. Can. Dept. Forest. 20(4):1-8.

521. Davis, Donald D. 1970. Distribution of Dutch Elm Disease in the United States. Plant Dis. Reporter. 54:929-930.
522. Davis, Donald D., Garland N. Mason and Paul H. Peacher. 1970. Dutch Elm Disease Detected in Texas. Plant Dis. Reporter 54:931.
523. Davis, J. D., R. Saigo and R. D. Evert. 1972. Some Effects of *Ceratocystis ulmi* on the Phloem and Vascular Cambium of *Ulmus americana*. Canadian Journal of Botany 50(5):1009-1013.
524. Day, W. R. 1927. The Prohibition of the Importation of Elms and the New Disease. Quart. Jour. For. (London). 21:123-9.
525. Day, W. R. 1941. Forest Pathology. Rep. Imp. For. Inst. Oxford 1940-1941.
526. DeHoogh, J. 1933. Iepenziekte Bestrijding. (Elm Disease Control). Nederl. Boschb.-Tijdschr. 6:402.
527. Demorlaine, J. 1928. Sur la Maladie de l'Orme. Rev. Eaux et Forets 66:20-23.
528. Dickens, L. E. 1970. Dutch Elm Disease. Plant Pathology Newsletter, Coop. Extension Service, Colorado State University, Fort Collins.
529. Dickens, L. E., N. Oshima and S.R. Andrews. 1970. Distribution of Dutch Elm Disease in Colorado, 1969. Plant Disease Reporter 54:266-267.
530. Dietrich, H. 1936. Elm Bark Beetles in N.Y. State. Jour. Econ. Ent. 29:217. 1936.
531. Dietrich, J. A. 1963. The Outlook in the Old Dutch Elm Disease Area. Internatl. Shade Tree Conf. Proc. 39:131-142.
532. Dimitrov, T. 1935. Prinos kum Izuchvan Nasekomnite i Gubnite Urediteli v Nashite Gori Kulturi. (A Contribution to the Study of the Diseases Caused by Insects and Parasitic Fungi in the Forests of Bulgaria). Godishn. Sofusk. Univ. V. Agron.-Lesov. Gak. (Ann U. Sofia V. Fac. Agron. et Sylvic). 13 (2, Sylvic):220-52, See p/248 (and perhaps others), French Summary 1935.
533. Dimond, Albert E. 1947. Symptoms of Dutch Elm Disease Reproduced by Toxins of *Graphium ulmi* in Culture. Abstr. in Phytopath. 37(1):7.
534. Dimond, Albert E. 1947b. Oxyquinoline Benzoate Aids Suppression of Symptoms of Dutch Elm Disease. Abstr. in Phytopath. 37:848.
535. Dimond, Albert E. 1948. Chemotherapeutic Action of 8-Quinolinol Benzoate Against Dutch Elm Disease. Abstr. in Phytopath. 38(1):7-8.

536. Dimond, Albert E. 1955. Pathogenesis in the Wilt Disease. *Ann. Rev. Plant Physiol.* 6:329-350.
537. Dimond, Albert E. 1962. Dutch Elm Disease Control by Chemotherapy. *Front. Plant Sci.* 14(2):4-5.
538. Dimond, Albert E. 1969. Disease Control With Systematic Treatments. *Internat. Sym. on the Dutch Elm Disease. Ames, Iowa. Proceedings.* (Unpublished).
539. Dimond, Albert E. and E. M. Stoddard. 1948. Chemotherapy. *Proc. Natl. Shade Tree Conf.* 24. 1948.
540. Dimond, Albert E. and D. Davis. 1952. 2 Carboxymethylmercaptobenzo-thiazole Salts as Chemotherapeutants for Plant Diseases. *Abstr. in Phytopath.* 42:7.
541. Dimond Albert E. and A. Hussain. 1958. Role of Extracellular Enzymes in the Pathogenesis of Dutch Elm Disease. *Science* 127:1059.
542. Dimond, Albert E., J. G. Horsfall and E. M. Stoddard. 1947. Progress in the Chemotherapy of Dutch Elm Disease. *Nat'l Shade Tree Conf. Proc.* 23:130-147.
543. Dimond, Albert E., G. H. Plumb, E. M. Stoddard and J. G. Horsfall. 1949. An Evaluation of Chemotherapy and Vector Control by Insecticides for Combating Dutch Elm Disease. *Connecticut Agr. Exp. Sta. Bulletin #531.* 69 pp.
544. Dimond, Albert, E. et al. 1941. Role of the Dosage-response Curve in the Evaluation of Fungicides. *Conn. Agr. Exp. Sta. Bull.* 451. 1941.
545. Dimond, Albert E. et al. 1943. A Water Soluble Protectant Fungicide With Tenacity. *Phytopath.* 33:1095-1097. 1943.
546. Dimond, Albert E. et al. 1947. Chemotherapy of Dutch Elm Disease. *Trees* 7:6-7; 13-15, 1947.
547. Dissel, E. D. 1936. In Memoriam to Dr. Christine Johanna Buisman. *Tijdschr. Nederl. Heidemaatsch.* 48:162-3, Illus.
548. Dixon, E. B. 1964. Attack Response of the Smaller European Elm Bark Beetle, *Scolytus multistriatus*, in Confinement. *Jour. Econ. Ent.* 57:170-172.

549. Doane, C. C. 1958. Insecticides to Prevent the Emergence of *Scolytus multistriatus*. J. Econ. Ent. 51(4):469-71.
550. Doane, C. C. 1958. The Residual Toxicity of Insecticides to *Scolytus multistriatus*. J. Econ. Ent. 51(2):256-57.
551. Doane, C. C. 1959. *Beauveria bassiana* as a Pathogen of *Scolytus multistriatus*. Ann. Ent. Soc. Am. 52:109-111, 1959.
552. Doane, C. C. 1960. Bacterial Pathogens of *Scolytus multistriatus* Marsham, as Related to Crowding. Jour. Insect. Path. 2:24-29. 1960.
553. Doane, C. C. 1962. Dutch Elm Disease. Control of Vectors. Front. Plant Science 14(2):5-7.
554. Doane, C. C. 1962. Evaluation of Insecticides for Control of the Smaller European Elm Bark Beetle. Jour. Econ. Ent. 55:414-415.
555. Dodd, H. J. 1934. Status of the Dutch Elm Disease in New Jersey. The Shade Tree 7(2):2.
556. Dodd, H. J. 1934. The Dutch Elm Disease Situation. The Shade Tree 7(4):3.
557. Dodge, B. O. 1933. Dutch Elm Disease in a Neighboring State. Jour. New York Bot. Gard. 34:170-1.
558. Dodge, B. O. 1935. Situation Regarding Dutch Elm Disease, the Japanese Beetle, and the Gypsy Moth at the Botanical Garden. Jour. New York Bot. Gard. 36:247-252.
559. Dominicus, J. K. 1923. De Iepen ziekte (The Elm Disease). Floralia 44:738-9, Illustrated.
560. Dominik, T. 1937. (Some Observations on the Dutch Elm Disease Caused by *Graphium ulmi*). Roczn. Nauk. Rol. 38(1):134-140.
561. Dominik, T. and K. Zaleski. 1936. Grozna Choroba Wiazow i Mozliwosci jej Zwalczenia. (The Elm Disease and the American Methods of Combating it). Roczn. Nauk. Rolnicz. i Lesn. Poznan (Polish Agr. and For. Ann.) 36(1):168-76, Illustrated French Summary.
562. Dooling, O., S. Kohler and G. Marks. 1973. Dutch Elm Disease in Montana. USFS/Northern Region Rep. No. 73-11.
563. Doorenbos, S. G. A. 1931. (Kinds of Elms in Relation to the Prevalent Elm Disease). Jaarb. Nederl. Dendrol. Vereenig 6 (1930):172-4.

564. Doskotch, R. W., S. K. Chatterji and J. W. Peacock. 1970. Elm Bark Derived Feeding Stimulants for the Smaller European Elm Bark Beetle. Science 167:380-81.
565. Doskotch, R. W. et al. 1973. Structure of the Water-Soluble feeding Stimulant for *Scolytus multistriatus*: A Revision. Phytochem. 12:1153-1155.
566. Doskotch, R. W. et al. 1975 Isolation and Identification of an Antifungal Agent from Seeds of American Elm. Phytopath. 65(5):634.
567. Dotti, F. 1935. (The Problem of Keeping the Vines in Romagna in the Face of the Elm Disease). Romagna Agr. Zootecn. 29:177-216, Illus.
568. Doudina, V. S. 1938. The Dutch Disease of Elms. (*Graphium ulmi* Schw.) State Publ. Off. Lit. Collect. Co-op. Farming. Moscow. pp 47.
569. Draghetti, A. 1932. (Progress *Ulmus* Disease by *Ceratocystis ulmi* at Modena). Ann. R. Staz. Sper. Agr. Modena 2:300-304.
570. Drumaux, L. 1932. (The Cause of the Elm Disease). Ann. R. Staz. Sper. Agr. Modena n.s. 2(1930-31):300-4.
571. Dufrenoy, J. 1923. Le Deperissement des Ormes. Rev. Eaux et Forest 61:361-363.
572. Durzan, D. J. and S. M. Lopishonski. 1975. Propagation of American Elm via Cell Suspension Cultures. Can. Jour. For. Res 5(2):273-278.
573. Dwinell, L. D. and W. A. Sinclair. 1965. Effects of N, P, K, and Inoculum Density on *Verticillium* Wilt of American Elm and Sugar Maple. Abstr. in Phytopath. 55:1056.
574. Ebrahimi, A. G. and H. S. McNabb, Jr. 1970. Coremia Production by *Ceratocystis ulmi* on Fresh Plant Material. Proc. Iowa Academy of Science 77:19-22.
575. Ebrahimi, A. G. and H. S. McNabb, Jr. 1972. Coremia Production of *Ceratocystis ulmi* Growing on Fresh Plant Material. Entomologie et Phytopathologie appliquees 32:4-7, 26-30.
576. Edgington, L. V. 1963. A Chemical that Retards Development of Dutch Elm Disease. Abstr. in Phytopath. 53:349.
577. Edgington, L. V. 1966. Effect of Chain Length of the Alkyl Quaternary Ammonium Compounds Upon Their Use as Systemic Fungicides. Phytopath. 56:23-25.

578. Edington, L. V. and A. E. Dimond. 1964. The Effect of Adsorption of Organic Cations to Plant Tissue on Their Use as Systemic Fungicides. *Phytopath.* 54:1193-1197.
579. Edson, H. A. 1934. U.S.A.: Dutch Elm Disease. *Intern. Bulletin Plant Prot.* 3:266.
580. Elgersma, D. M. 1967. Factors Determining Resistance of Elms to *Ceratocystis ulmi*. *Phytopath.* 57:641-42.
581. Elgersma, D. M. 1969. Resistance Mechanisms of Elms to *Ceratocystis ulmi*. *Meded. Phytopath. Lab. Scholten.* #77 pp. 84.
582. Elgersma, D. M. 1970. Length and Diameter of Xylem Vessels as Factors in Resistance of Elms to *Ceratocystis ulmi*. *Neth. J. Pl. Path.* 76(3):179-182.
583. Elgersma, D. M. 1970b. Transport and Multiplication of Spores of *Ceratocystis ulmi* (Buisman) C. Moreau in Susceptible and Resistant Elms. *Proc. Internat. Sym. on Dutch Elm Disease 1968.* Iowa State Univ. Press, Ames, Iowa.
584. Elgren, J. W. et al. Undated. Laboratory and Cultural Techniques Related to Identification of the Dutch Elm Disease Fungus. *Exten. Service, Univ. of Nebraska, College of Agriculture.*
585. English, L. L. and Walter Hartstirn. 1962. Systemic Insecticide Control of Some Pests of Trees and Shrubs--a Preliminary Report. *Illinois Natural History Survey Biological Notes No. 48.* 12 p.
586. Epstein, A. H. 1959. Aerial Survey for Dutch Elm Disease. *Plant Disease Reporter* 43(10):1078.
587. Epstein, A. H. 1969. *Ceratocystis ulmi* (Buism.) C. Moreau in Roots of *Ulmus americana* L. Ph.D. Thesis, Iowa State University Library. 70 p.
588. Epstein, A. H. 1969. Low Temperature Sprays for Dutch Elm Disease Controls. *Plant Dis. Reporter* 53:304-306.
589. Epstein, A. H., and E. B. Smalley. 1962. An Evaluation of Sodium Hypochlorite Soil Applications for Control of Dutch Elm Disease. *Plant Disease Reporter* 46:216-217.
590. Falck, R. 1926. Ueber das Ulminsterben in Holland. (On the Elm Disease in Holland). *Forstarchiv Ztschr. Wissenschaftl. u. Techn. Fortschr. in Forstwirtschaft.* 2:66-9.

591. Fate, L. A., Clyde E. Dike and O. N. Liming. 1947. Culture Techniques for Large Numbers of Diseased and Dead Wood Specimens. Abstr. in Phytopath. 37:7.
592. Faul1, J. H. 1935. Can We Eradicate the Dutch Elm Disease? The Shade Tree 5(8):2-4.
593. Faul1, J. H. 1936. The Viewpoint of the Arnold Arboretum on the Dutch Elm Disease. Bull. Pop. Inform. Arnold Arb. IV, 4:15-20, April 1, 1936.
594. Feldman, A. W. and N. E. Caroselli. 1951. Soil and Tree Acidity in Relation to Susceptability to Dutch Elm Disease. Abstr. in Phytopath. 41:12.
595. Feldman, A. W. et al. 1949. Physiological and Chemotherapeutic Investigations of *Ceratostomella ulmi*. Abstr. in Phytopath. 39:6.
596. Feldman, A. W. et al. 1950. Chemicals for Dutch Elm Disease Therapy. Phytopath. 40:8-9.
597. Feldman, A. W. et al. 1950. Physiology of Toxin Production by *Ceratostomella ulmi*. Phytopath. 40(1):341-354.
598. Felt, E. P. 1933. Are Our Elms Going? Tree Talk 9:3-6.
599. Felt, E. P. 1933. The Dutch Elm Disease (*Graphium ulmi*) and its Control. Bartlett Tree Res. Lab. Ed. Bulletin 60:1-23, Illus.
600. Felt, E. P. 1934. Dutch Elm Disease Control and the Elm Bark Borer. Jour. Econ. Ent. 27:315-9.
601. Felt, E. P. 1934. Dutch Elm Disease and its Control. Bartlett Tree Res. Lab. Circ. Inf. 1-8.
602. Felt, E. P. 1934. Some Shade Tree Problems. The Shade Tree (N.J.) 6:1-2.
603. Felt, E. P. 1934. What About Our Shade Trees? Bartlett Tree Res. Lab. Ed. Bull. 61:3-12.
604. Felt, E. P. 1935. Bark Beetles and the Dutch Elm Disease. Jour. Econ. Ent. 28:231-236.
605. Felt, E. P. 1937. Balloon Drift and Insect Drift. Ent. News 48:17. 1937.

606. Felt, E. P. 1937. Balloons as Indicators of Insect Drift and of Dutch Elm Disease Spread. Bartlett Tree Res. Lab., Bull. No. 2:3-10. 1937.
607. Felt, E. P. 1937. Dissemination of Insects by Air Currents. Jour. Econ. Ent. 30:458-461. 1937.
608. Felt, E. P. 1939. Balloon Releases and Dutch Elm Disease Spread. Bull. Bartlett Tree Res. Lab. No. 3. 20-25.
609. Felt, E. P. 1940. European Elm Bark Beetle and Dutch Elm Disease Control. J. Econ. Ent. 33(3):556-558.
610. Felt, E. P. 1943. Dutch Elm Disease Control. Sci. Tree Trop. (1)8:58-64.
611. Felt, E. P. and S. W. Bromely. 1937. Scientific Contributions. Bartlett Tree Res. Lab. Bulletin. 2:24 pp. see p. 3-10, Illus.
612. Felt, E. P. and S. W. Bromely. 1938. Shade Tree Insects and Sprays, 1937. Jour. Econ. Ent. 31:174. 1938.
613. Felt, E. P. and S. W. Bromely. 1941. New and Unusual Shade Tree Pests. Jour. Econ. Ent. 34(3):383-386, 1941.
614. Fenaroli, L. 1932. Gli Olmi. (The Elms.) Alpe. Riv. For. Ital. 19:119-27, Apr./May 1932.
615. Fenner, L. M. and L. R. Fate. 1947. *Ceratostomella ulmi* on Elm Bark Treated With 2, 4-D. Phytopath. 37:925-928.
616. Fenner, L. M. and O. N. Liming. 1947. Identification of *Ceratocystis ulmi* in Pure Cultures and in Mixed Associations of Organisms. Abstr. in Phytopath. 37:7.
617. Ferdinandsen, C. Von. 1929. (Quarantine Against Elms). Dansk. Skovfor. Tidsskr. 14:359.
618. Fergus, C. L. 1956. The Influence of Actidione on Wood-staining Fungi. Mycologia 48:468-472.
619. Fetles, J. J. 1964. Protection of Healthy Trees by Chemical Insecticides. (In a Review of the Dutch Elm Disease). Can. Dept. For. Bi-Mon. Prog. Report 20:4.
620. Feucht, James. 1969a. Systemic Fungicides for Dutch Elm Disease. Metro Horticulture 4(2):3.

621. Feucht, James. 1969b. Dutch Elm Disease Survey Report. (Snyder, Gilmore, Dickens) Metro Horticulture 4(2):6.
622. Feucht, James. 1970. Disposal Problem - Dutch Elm Disease. Metro Horticulture 5(3):5.
623. Filley, W. O. 1935. Dutch Elm Disease Situation in Connecticut. Proc. Nat. Shade Tree Conf. 11:143-145.
624. Filley, W. O. 1936. The Dutch Elm Disease Situation. Connecticut Woodlands No. 1. 1:11-12.
625. Finnegan, R. J. 1950. Bionomics of the Native Elm Bark Beetle, *Hylurgopinus rufipes* (Eich.), in Quebec. M. Sc. Thesis, Univ. of New Brunswick, Fredericton, N.B. p. 62. 1950.
626. Finnegan, R. J. 1957. Elm Bark Beetles in Southwestern Ontario. Can. Ent. 89:275-280.
627. Finnegan, R. J. 1964. *Xyloterinus politus* (Say), Another Vector of the Dutch Elm Disease. Bi-Mon. Prog. Rep. Dep. For Can. 20(6):2-3.
628. Finnegan, R. J. 1964. Role des Insects dans la Transmission de la Maladie Hollandaise de l' Orme, *Ceratocystis ulmi* (Buisman) C. Moreau. Phytoprotection 45:117-124.
629. Finnegan, R. J. and W. L. Sipple. 1964. Vector of the Disease. In a Review of the Dutch Elm Disease. Can. Dept. of For. Bi-mon. Prog. Rept. 20(4):1-8.
630. Fischer, R. 1931. Das Ulmensterben. (The Elm Disease). Die Natur. (Vienna) Abb. 2:61.
631. Fisher, R. C. 1931. Relation of the Elm Bark beetles to their Hosts. Forestry 5:120-131.
632. Fisher, R. C. 1937. The Genus *Scolytus* in Great Britain With Notes on the Structure of *S. destructor* O. Ann. Appl. Biol. 24(1):110-130.
633. Foex, E. 1922. Mlles Spierinburg: Schwarz.-Deperissement des Ormes-*Ulmus campestris* et Autres Espces d'*Ulmus*. Bull. Soc. Veg. 9:200-204.
634. Foex, E. 1922. La maladie des Ormes. (The Elm Disease). Jour. Soc. Nat. Hort. France, Ser. IV. 23:409-11.

635. Forestry Commission. 1932. Elm Disease: The Present Position. Scot. For. Jour. 46:194-196.
636. Forestry Commission. 1933. Elm Disease (*Graphium ulmi* Schwarz). For. Comm. London Leaflet 19:1-18.
637. Forestry Commission. 1934. Elm Diseases in Great Britain. Mimeo Report 1934:1-2, 031.
638. Forestry Commission, U. K. 1973. Report on Forest Research for the Year Ending March, 1973. (DED - Gibbs, Brasier & Burdekin). London, U. K. HMSO (1973) 189 pp.
639. Forestry Commission. 1974. Elm Disease. Research on Fungicide Injection. Quarterly Jour. of Forestry 68(1):76-78.
640. Forestry Commission, U. K. 1974. Report on Forest Research for the Year Ending March, 1974. London, U. K. H.M.S.O. (1974) vii + 109 pp. pp. 36-38.
641. Fox, R. C. 1958. Seasonal Development of the Smaller European Elm Bark Beetle in Southern Michigan. Mich. Agr. Exp. Sta. Qtrly. Bull. 41(2): 279-287.
642. Fracker, Stanley B. 1935. Is America About to Lose Her Elms? Scientific Monthly 40:70-73.
643. Fracker, Stanley B. 1936. Progressive Intensification of Uncontrolled Plant Disease Outbreaks. Jour. Econ. Ent. 29:923-940. 1936.
644. Franceschi, L. 1934. L'Invasione Parassitaria una Minaccia al Susino Burbank. (A Parasitic Invasion Endangers the Burbank Plum). Giorn. Ital. Agr. (Rome) 17:5.
645. Fransen, J. J. 1931. De Verbreiding der Iepen ziekte Door de Iepenspintkevers en de Bestryding van dit Insect in Practyk. (The Spreading of the Elm Disease by the Elm Sapwood Beetle and the Control of This Insect in Practice). Tijdschr. Plantenz. 37:169-187, Illus.
646. Fransen, J. J. 1931. (Some Data Concerning the Dissemination of the Elm Disease--*Scolytus scolytus* and *S. multistriatus*). Tijdschr. over Plantenziekten 37:49-62.
647. Fransen, J. J. 1931. Enkele Gegevens Omtrent de Verspreiding van de orr *Graphium ulmi* Schwarz Veroorzakte Iepen ziekte Door de Iepenspintkevers, *Eccoptogaster (Scolytus) scolytus* F. en *Eccoptogaster (Scolytus) multistriatus* Marsh. in Verband met de Bestrijding Dezer Ziekte. Tijdschr. PiZiekt. 37(3):49-62, 1931.

648. Fransen, J. J. 1932. De Kleine Iepenspintkever *Scolytus (Eccoptogaster) multistriatus* Marsh. als Verbreder der Iepenziekte. (The Small Elm Sapwood Beetle **** as a Vector of the Elm Disease). Tijdschr. Plantenz. 38:197-202, Illus.
649. Fransen, J. J. 1935. (Investigations on the Elm Disease Conducted at the Laboratory for Entomology at Wageningen in 1934). Tijdschr. Plzeikt. 41:240-260.
650. Fransen, j. j. 1937. (Report on the Investigations Relating to Elm Disease and Elm Bark Beetles). Tijdschr. Plzeikt. 43(4):195-217.
651. Fransen, J. J. 1937. De Verbreiding van *Ceratostomella ulmi* (Schwarz) Buisman Door den Wind. Tijdschr. Plziekt. 43:218-222. 1937.
652. Fransen, J. J. 1939a. Iepenziekte, Iepenspintkevers en Beider Bestryding. (The Elm Disease, Elm Bark Beetles, and Their Control). Thesis, Wageningen Agric. College, 1939.
653. Fransen, J. J. 1939b. De Smakelijkheid van Verschillende Soorten Iepen Voor de Iepenspintkevers. Landbouwk. Tijdschr. 51:435-523.
654. Fransen, J. J. and Christine J. Buisman. 1935. Infectieproeven op Verschillende Iepensoorten met Behulp van Iepenspintkevers. Med. Iepenziekte-Comite' No. 19:1-19. (English Translation - Tijdschr. Plzeikt. 41:(221-239).
655. Frederick, L. and F. L. Howard. 1951. Comparative Physiology and Pathogenicity of Eight Isolates of *Ceratostomella ulmi*. Phytopath. 41(1):12-13.
656. Fremd, C. 1937. Is the American Elm Doomed? Flor. Exch. 88:34B.
657. French, D. W. and A. C. Hodson. 1961. The Dutch Elm Disease. University of Minnesota Agr. Ext. Ser. 211.
658. French, D. W. and M. G. Marinos. 1970. Dutch Elm Disease in Minn., 1961-1970. Plant Disease Reporter 54:706-707.
659. Fries, N. 1942. On the Growth Substance Requirement of *C. ulmi* Species. Svensk. Bot. Tidskr. 36:451-466.

660. Fron, G. 1936. La Lutte Contre les Trachemycoses des Plantes. (The Struggle Against the Vascular Diseases of Plants). Compt. Rend. Acad. Sci. Paris 203:1385-6.
661. Fron, G. 1936. La Maladie de l'Orme. (The Elm Disease). Compt. Rend. Acad. Agr. France 38:1081-1089.
662. Fron, G. 1937. La Maladie de l'Orme. (The Elm Disease). Rev. Eaux. and For., Ser. VI, 75 (Ann. 35):193-200, Illus.
663. Gage, G. R. 1935. The Present Status of the Dutch Elm Disease. Jour. Tenn. Acad. Sci. 10:83-5.
664. Gage, G. R. 1936. A Second Report on the Status of the Dutch Elm Disease. Jour. Tenn. Acad. Sci. 11:141.
665. Gagnon, C. 1961. Growth of *Ceratocystis ulmi* (Buis.) C. Moreau in Liquid Culture Media. Can. Jour. Bot. 39:1087-1093.
666. Gagnon, C. 1964. Mechanism of Pathogenesis. In a Review of the Dutch Elm Disease. Can. Dept. For. Bi-mon. Rept. 20(4):1-8.
667. Gagnon, C. 1966. Fungus Culture on Cellophane Membrane for Cytochemical Tests. Stain Tech. 41:247.
668. Gagnon, C. 1967. Histochemical Studies of the Alteration of Lignin and Pectic Substances in White Elm Infected by *Ceratocystis ulmi*. Can. Jour. Bot. 45:1619-1623.
669. Gagnon, C. 1967. Polyphenols and Discoloration in the Elm Disease Investigated by Histochemical Techniques. Can. Jour. Bot. 45: 2119-2124.
670. Gagnon, C. 1968. Peroxidase in Healthy and Diseased Elm Trees Investigated by the Benzidine Histochemical Technique. Can. Jour. Bot. 46:1491-1494.
671. Gagnon, C. 1969. Technique Histochemique pour l'Etude de la Polyphenoloxydase dans le Xyleme de l'Orme d'Amerique. Naturaliste Can. 96:203-210.
672. Galford, Jimmy R. 1969. A Larval and Ovipositional Medium for the Smaller European Elm Bark Beetle. Jour. Econ. Ent. 62(5):1166-1168.
673. Gallot, --. 1928. Note Relative a la Maladie des Ormes. (Note to the Elm Disease). Bull. Soc. Centr. For. Belgique 35(1):206-7.

674. Gama, M. I. 1960. (Dutch Elm Disease). Publ. Serv. Flor. Agric. Portugal 27(1):5-6.
675. Gams, W. 1968. Taxonomic Criteria in the Genus *Cephalosporium*. Acta. My. Col. 4:205-208.
676. Garbers, F. 1930. Der Stand des Ulmensterbens u. Seine Enforshung. (The Position of Dying-off of Elms and its Investigation). Gartenwelt. 34(41):563-564.
677. Garbers, F. 1930. (On the Elm Dying). Prakt. Ratgeb. Obst-u Gartenb. 45:497-9, Illus.
678. Garbers, F. 1931. Welche Massnahmen Gegen das Ulmensterben? Gartenwelt. 35:113-5.
679. Garbers, F. et al. 1931 Das Rätselhafte Grosse Ulmensterber. Gartenwelt. 35:113-5, Feb. 27, 1931.
680. Gardiner, L. M. 1973. Developing Control of Insect Vectors of Dutch Elm Disease. Alt. in Forest Insect Control. p 10-18. Can. For. Serv., Sault Ste. Marie, Ont. Symp. Proc. o-p-2.
681. Gerlach, H. 1930. Vom Baumsterben and Ulmensterben Insbeonbdere. (On Tree Diseases, Especially the Elm Disease). Mollers Deut. Gart.-Ztg. 45:327.
682. Georgevitch, P. 1933. (The Elm Disease in Slavonic Forests.) Beograd Publ. of Inst. Rech. For. Belgrade. 1933, 1-32 pp. Illus.
683. Gibbs, J. N. 1971a. Dutch Elm Disease. Forestry Comm. HMSO Leaflet 19, 8 p.
684. Gibbs, J. N. 1971b. Dutch Elm Disease. Rep. Forest Res., Lond. pp. 78-79.
685. Gibbs, J. N. 1973 Continuing the DED fight - Two Reports on Benomyl. Benlate Still Best. Gardners Chronicle 173(4):24, 26.
686. Gibbs, J. N. 1974. Biology of Dutch Elm Disease. Forestry Commission Forest Recrod 94.
687. Gibbs, J. N. and R. S. Howell. 1972. Dutch Elm Disease Survey 1971. HMSO Forestry Commission Forest Record 82, 34 pp.

688. Gibbs, J. N. and C. M. Braiser. 1973. Correlation Between Cultural Characters and Pathogenicity in *Ceratocystis ulmi* from Britain, Europe and America. *Nature* 241:381-383.
689. Gibbs, J. N. and D. R. Clifford, 1974. Experiments with MBC Derivatives for the Control of Dutch Elm Disease. *Ann. Appl. Bio.* 78(3):309-318.
690. Gibbs, J. N. and R. S. Howell. 1974. Dutch Elm Disease Survey 1972-1973. Forestry Commission Forest Record 100.
691. Gibbs, J. N. , H. M. Heybroek and F. W. Holmes. 1972. Aggressive Strain of *Ceratocystis ulmi* in Britain. *Nature* 236:121-122.
692. Gibbs, J. N. et al. 1975. Further Studeis on Pathogenicity in *Ceratocystis ulmi*. *Eur. Jour. For. Path.* 5(3):161-174.
693. Gilbert, B. L. and D. M. Norris. 1968. A Chemical Basis for Bark Beetle (*Scolytus*) Distinction Between Host and Non-host Trees. *J. Insect Physiol.* 14:1063-1068.
694. Gilbert, B. L., J. E. Baker and D. M. Norris. 1967. Juglone (5-Hydroxy-1 4-Naphthoquinone) from *Carya ovata* a Deterrent to Feeding by *Scolytus multistriatus*. *Jour. Insect Physiol.* 13:1453-1459.
695. Goedon, R. D. and D. M. Norris. 1963. The Potential of *Magdalis* Spp. in the Transmission of *Ceratocystis ulmi*. *Jour. Econ. Ent.* 56: 238-239.
696. Goetz, O. 1935. Die Italienischen Burbank-Pflaumenanlagen Durch *Graphium ulmi* Zerstort? (Are the Italian Burbank Plum Plantings Destroyed by *Graphium ulmi*?). *Obst-u. Gemusb.* 81:28.
697. Goidanich, A. and G. Goidanch. 1934. Lo *Scolytus sulcifrons* Rey (Coleoptera-Scolytidae) nella Diffusione del Pirenomicete *Cerato- stomella (Graphium) ulmi* (Schwarz) Buis. nell''Emilia. (*Scolytus sulcifrons***** in the Dissemination of the Pyrenomycete **** in Emilia). *Boll. Lab. Entom. Bologna* 7:145-63, Illustrated.
697. Goidanich, A. and G. Goidanich. 1934. Moria Degli Olmie Scolitidi. *L'Italia Agricola* No. 10. 71:941-948.
698. Goidanich, G. 1933. Il Deperimento dei Su ini. *Boll. R. Staz. Pat. Veg. n.s.* 13:160-173.
699. Goidanich, G. 1935. Il Deperimento dei susini. Chiarimenti Sulla Nuova Malattie. (The Dying of Plums. Concerning a New Disease). *Giorn. Ital. Agr. (Rome)*. 18:4.

700. Goidanich, G. 1935. Nouvi Casi di Tracheomicosi da *Verticillium* in Italia. Osservazioni su una Specie Nuova di *Verticillium tracheicolo*. Boll. Staz. Patol. Veg. Roma n.s., 15(4)548-554.
701. Goidanich, G. 1935. (Staining of Timber in Italy.) Boll. Patol. Veg. (Rome) n.s. 15:363-88, Illustrated.
702. Goidanich, G. 1935. Ueber die Wahre Ursache des Burbanksterbens in Italien. Zeitschr. Pflanzenkr. 45:335-340. f. 1-7.
703. Goidanich, G. 1935. Una Nuova Specie di "*Ophiostoma*" Vivente sul Pero ed Alcune Osservazioni sull'Esatta Posizione Sistemica della Forma Ascofora e delle Forme Metagenetiche del Genere. Bol. R. Staz. Pat. Veg. n.s. 15:122-168.
704. Goidanich, G. 1935. Schema di una Classificazione delle Stilbacee che Erano Riunite Fin'ora nel Genere *Graphium* Corda. (A Scheme of Classification of the Stilbaceae Hither to included in the Genus *Graphium* Corda.) Ann. Bot. (Rome) 21:40-50, Dec. 28, 1935.
705. Goidanich, G. 1936. Comportamento dell' "*Ulmus pumila*" L. nella Pratica Agricola e la sua Resistenza Alla Grafioso. (Behavior of *U. pumila* L. Agricultural Practice and its Resistance to the Elm Disease). Boll R. Staz. Patol. Veg. (Rome) n.s. 16:199-207, Illustrated.
706. Goidanich, G. 1936. La "Moria del' Olmo" (*Graphium ulmi*). (The Elm Disease ****). 134 pp. Illus. Bibl. of Popular Italian Refs. (Rev. by R. K. Beattie in Jour. For. 35:319-320.)
707. Goidanich, G. 1937. Das Ulmensterber in Italian. Pflkrankh. 47(8): 417-425.
708. Goidanich, G. 1938. Notizie sulle Ricerche di Silezoine di Olmi Resistenti alla Graphiosi. (Notes on Researches on the Selection of Elms Resistant to Graphiosis). Ital. Agric. LXXV 1938.
709. Goidanich, G. 1941. Il Problema della Grafiosi dell' Olmo nell Fase Risolutiva. Accad. A. Gr. Bologna Ann. n.s. 1:23.
710. Goidanich, G. 1946. L'Olmo Buisman. Boll. Staz. Pat. Veg. 21(3):270-286.
711. Goidanich, G. and F. Azzaroli. 1938. Relazione sulle Esperienze di Selezione di Olmi Resistenti alla Grafiosi e di Inoculazioni Artificiali di *Graphium ulmi* Esquite nel 1937. Boll. Staz. Pat. Veg. Roma n.s. XVII 149-178.

712. Goidanich, G. and F. Azzaroli. 1939. Relazione sulle Esperienze di Selezione di Olmi Resistenti alla Grafiosi e di Inoculazioni Artificiali di *Graphium ulmi* Esquite nel 1938. Boll. Staz. Pat. Veg. Roma n.s. XIX. 222:1.
713. Goidanich, G. and F. Azzaroli. 1946. Relazione sulle Esperienze di Selezione di Olmi Resistenti alla Grafiosi e di Inoculazioni Artificiali di *Graphium ulmi* Esquite nel 1939-40. Boll. Staz. Pat. Veg. Roma, n.s. 21(3):287-306.
714. Gold-Karstadt, H. 1932. Soll Man Noch Ulmen Pflanzen? (Shall Elms Still be Planted?). Gartenwelt. 36:9.
715. Goss, Marie C. and R. K. Beattie. 1935. Misleading, Unproven Reports of *Graphium ulmi* on Burbank Plum. Plant Disease Reporter 19:148-150.
716. Goss, Marie C. and C. S. Moses. 1937. A Bibliography of the Dutch Elm Disease. U.S. Bur. Plant Ind. Div. For. Path. (Processed)
717. Goss, R. W. and P. R. Frink. 1934. *Cephalosporium* Wilt and Die-back of the White Elm. Nebr. Agr. Exp. Sta. Res. Bull. 70. 24 pp.
718. Gradwell, G. R. et al. 1973. In the Forty-ninth Ann. Rep. of the Commonwealth For. Inst., Univ. of Oxford, 1972-1973. 32 pp.
719. Graffin, R. 1920. Sur la Disparition de l'Orme Sous les Gaz de Guerre. (On the Disappearance of the Elm as a Result of Gasing in the War). Compt. Rend. Acad. Agr. France 6:609.
720. Graham, T. W. 1936. Persistence of *Ceratostomella ulmi* in Stumps of Eradicated Dutch Elm Diseased Trees in New Jersey. Plant Disease Reporter 20:320-322. (Processed)
721. Gram, E. 1955. Outbreaks and New Records. Denmark F.A.O. Plant Prot. Bull. 4(1):1-13.
722. Gravatt, G. F. and R. S. Clapper. 1932. *Verticillium* Wilt of Maple, *Ailanthus*, and Elm. Plant Dis. Reporter. 16:96-8.
723. Gravatt, G. F. and M. E. Fowler. 1933. Log Interceptions at Norfolk in Relation to the Entry of Tree Diseases. Plant Dis. Reporter 17:129-133.
724. Great Britain, Forestry Comm. 1928. The Dutch Elm Disease (*Graphium ulmi*) Schwarz. Leaflet #19:6 pp., Illustrated.

725. Great Britain, Forestry Comm. 1936. (No Title) Annual Reports 8:28, 9:28, 10:23, 11:30, 12:36, 14:34, 15:41, 16:37. (Brief Summaries of the Status of the Elm Disease in England as Revealed by Annual Surveys).
726. Great Britain, Imperial Forestry Institute, Univ. of Oxford. 1937. (No Title). Annual Reports 4:10, 4:16, 6:10, 7:9, 8:13, 9:14, 10:19-20, 1:14-15, 12:17. (Brief Summaries of the Status of the Elm Disease).
727. Gregor, M. J. 1929. Ueber das Ulmensterben and Seiner Erreger. Ztschr. Pflanzenkr. 39:36-9.
728. Gregor, M. J. 1932. A Study of Heterothallism in *Ceratostomella pluriannulata* Hedgcock. Amer. Myc. 30:1-19.
729. Gregory, G. F., T. W. Jones and Percy McWain. 1971. Injection of Benomyl into Elm, Oak, and Maple. USFS Research Paper NE-232.
730. Gregory, G. F., T. W. Jones, and P. McWain. 1973. Pressure Injection of Methyl-2-Benzimidazole Carbamate Hydrochloride Solution as a Control for Dutch Elm Disease. USFS Res. Note NE-176.
731. Gries, G. A. 1943. Juglone (5-hydroxy-1, 4-naphthoquinone) - A Promising Fungicide. Phytopath. 33:112. 1943.
732. Griffin, H. D. 1964. The Perithecial State of *Ceratocystis ulmi* in Ontario. Plant Disease Reporter 48:615.
733. Griffin, H. D. 1968. The Genus *Ceratocystis* in Ontario. Can. Jour. Bot. 46:689-718.
734. Grossbard, E. 1954. Effects of Metabolites of Actinomycetes on Pigmentation and Spore Formation in Phytopathogens. Abstr. in Phytopath. 44:111.
735. Grossman, H. 1930. Beitrage fur Kenntnis der Lebensgemeinschaft Wischen Barken Kafern and Pilzen. (Contributions to the Knowledge Concerning the Life Partnership Between Bark Beetles and Fungi). Zeitschr. Fur. Parasiten. 3(1):56-102.
736. Grossman, H. 1932. Das Ulmensterben. (The Elm Disease). Schweiz. Zeitschr. Fur Forstwesen. 83:49-59.
737. Grove, A. 1931. The Elm Disease. Gard. Chron. 90:396.

738. Guinier, P. 1930. La Maladie des Ormes en France. Rev. Path. Veg. et Ent. Agr. 17:377-379.
739. Guinier, P. 1931. La Maladie des Ormes. Rev. Eaux et Forets 69:293-295.
740. Guinier, P. 1931. (Two New Cryptogamic Diseases of Forest Trees; the Elm Disease and the Red Needle Disease of Douglas Fir). Re. Eaux et For. Ser. VII. 69(Ann.29):292-9, see pp. 293-5.
741. Guryanova, T. M. 1961. (On the Role of Trunk Insects in the Development of Foci of Elm Disease). Trud. Khopersk. gos. Zapoved. 4:105-121.
742. Guyot, L. 1921. (Notes on Plant Pathology). Bull. Soc. Path. Veg. France 8:132-6.
743. Guyot, L. 1926. Le Deperissement des Ormes. (The Elm Dying). Jour. Agr. Prat. (France) n.s. 45(Ann. 90):53-4, illustrated.
744. Hafstad, G. E. 1958. Possible Long Distance Spread of Dutch Elm Disease by Transported Beetles. Plant Disease Reporter 42(7): 893-894.
745. Hagmann, L. E. 1945. Feeding Habits and Related Activities of the Two Elm Scolytids, *Scolytus multistriatus* (Marsham) and *Hylurgopinus rufipes* (Eichhoff) with Reference to the Spread of the Dutch Elm Disease Pathogen *Ceratostomella ulmi* (Schwarz) Buisman. Thesis for degree of Ph.D., Cornell Univ. (Unpublished).
746. Hale, Mary Jane. 1970. Dutch Elm Disease. Syracuse University Alumni News. Fall 1970.
747. Ham, D. L. 1972. Benlate -- Dutch Elm Disease. Reserch News No. 155. Bartlett Tree Res. Lab.
748. Harris, H. A. 1932. Initial Studies of American Elm Diseases in Illinois. Ill. Nat. Hist. Bulletin 20:70 pp., illustrated.
749. Harris, J. L. 1970. Surface Features of the Fruiting Structures of *Ceratocystis ulmi*. Mycologia 62:1130-1133.
750. Harris, J. L. 1975. Some Three-dimensional Aspects of *Ceratocystis ulmi* as Observed by High-voltage Electron Microscopy. Mycologia 67(2): 332-391.
751. Harris, J. L., and W. A. Taber. 1970. Influence of Certain Nutrients and Light on Growth and Morphogenesis of the Synnema of *Ceratocystis ulmi*. Mycologia 62:152-170.

752. Harris, James L. and Willard A. Taber. 1973. Compositional Studies on the Cell Walls of the Synnema and Vegetative Hyphae of *Ceratocystis ulmi*. Can. J. Bot. 51(6):1147-1155.
753. Hart, J. H. 1960. A Modified Method for Culturing Elm Samples. Plant Disease Reporter 44:806-807.
754. Hart, J. H. 1960. Water Relations and Colonization in Elm by *Ceratocystis ulmi*. Unpublished. M. S. Thesis, Iowa State Univ. Library, Ames, Iowa.
755. Hart, J. H. 1965. Economic Impact of Dutch Elm Disease in Michigan. Plant Disease Reporter. 54:985-986.
756. Hart, J. H. 1970. Attempts to Control Dutch Elm Disease by Pruning. Plant Disease Reporter 54:985-986.
757. Hart, John, 1972. Control of Dutch Elm Disease With Foliar Applications of Benomyl. Plant Disease Reporter 56(8):685-688.
758. Hart, J. H. and Wm. Ronald Landis. 1971. Rate and Extent of Colonization of Naturally and Artificially Inoculated American Elms by *Ceratocystis ulmi*. Phytopathology 11:1456-1458.
759. Hart, John H. and Harold S. McNabb, Jr. 1962. Viscosity Determinations of Xylary Fluid from Healthy and *Ceratocystis ulmi*-diseased Elms. Abstr. in Phytopathology 52:13.
760. Hart, J. H., W. E. Wallner, M. R. Caris and G. K. Dennis. 1967. Increase in Dutch Elm Disease Associated With Summer Trimming. Plant Disease Reporter 51:476-479.
761. Hartley, Carl and R. W. Davidson. 1950. Wetwood in Living Trees. Abstr. in Phytopath. 40:871.
762. Hartley, C. et al. 1961. Wetwood, Bacteria, and Increased PH. in Trees. U.S.F.S. Forest Prod. Lab. Rep. 2215, 34 pp.
763. Hartstirn, Walter. 1965. Bidrin--Dutch Elm Disease. Illinois Natural History Survey Mimeo. 1 p. March.
764. Haskell, R. J. and Jessie I. Wood. 1930. Elm (*Ulmus* spp.). Plant Disease Reporter Suppl. 75:70.
765. Hastings, A. R. and M. Beroza. 1961. Screening Tests of Chemical Deterrents. U.S.F.S. NE. Exp. Sta. Paper No. 156.

766. Hastings, A. R. and M. Beroza. 1970. Speech Outline.
767. Hauptfloisch, K. 1930. Pflanzenkrankheiten und Welthandel. (Plant Disease in World Commerce). Forstw. Centralbl. 74(Jahr 52, n.s.) 74-90.
768. Helburg, L. B., M. E. Schomaker and R. A. Morrow. 1973. A New Trunk Injection Technique for Systemic Chemicals. Plant Disease Reporter 57(6):513-14.
769. Henkel, Z. G. 1976. Elegy for an Elm. Phi Kappa Phi Jour. 56(1).
770. Hepting, G. H. 1967. International Tree Disease Register. Agr. Sci. Rev. 5(1):33-34.
771. Hepting, G. H. 1971. Diseases of Forest and Shade Trees of the United States. U.S.F.S. Agr. Handbook 386, 658 pp.
772. Herbert, V. L. 1965. The Liberty Tree of Boston, Our Country's First Symbol of Freedom. (2-page Illustrated Pamphlet).
773. Herrmann, E. 1931. Das "Ulmensterben". (The Elm Disease). Deut. Forst.-Ztg. 46:1151-1154.
774. Hesselink, E. 1924. Enkele Opmerkingen Naar Aanleiding van de "Iepen-ziekte". (A Few Remarks about the Elm Disease). Landbouwerk. Tijdschr. 36:446-8.
775. Heybroek, H. M. 1957. Elm-breeding in the Netherlands. Silvae Genet. 6:112-117.
776. Heybroek, H. M. 1961. De Iep 'Commelin'. Summary: The Elm 'Commelin'. Ned. Boschb. Tijdschr. 33:325-328.
777. Heybroek, H. M. 1962. Ulmen, Ulmus. In: Handbuch der Pflanzenzüchtung, Berlin and Hamburg, 6 Edition 2:819-824.
778. Heybroek, H. M. 1963. De Iep "Groeneveld". Ned. Bosb. Tijdschr. 35: 370-374.
779. Heybroek, H. M. 1963b. Jaarverslag over 1962. Stichting Bosbouwproefstation "De Dorschkamp." Afdeling Iepenonderzoek, mimeographed report, stencil number. 1963/22, 12-3:1-18.

780. Heybroek, H. M. 1964. Jaarverslag over 1963, Stichting Bosbouwprofefs-
tation "De Dorschkamp." Afdeling Iepenonderzoek, mimeographed report,
stencil number 20/1964, 26-2:1-27.
781. Heybroek, H. M. 1966. Dutch Elm Disease Abroad. Am. Forests. 72(6):
26-29.
782. Heybroek, H. M. 1967. The Dutch Elm Disease in the Old World. Proc.
14th Congr. Int. Union For. Res. Organ. Munich 1967. Pt. V. Sect.
24. 447-454.
783. Heybroek, H. M. 1969. Host Plant Resistance in Elms. Proc. N. Cent.
Br. E.S.A. 24:69-74.
784. Heybroek, H. M. 1970. Three Aspects of Breeding Trees for Disease Re-
sistance. In Proc. 2nd World Consult Forest Tree Breeding 1:519-535.
Rome: F.A.O., 872 pp.
785. Hickey, J. J. and L. B. Hunt. 1960. Initial Songbird Mortality Following a
Dutch Elm Disease Control Program. Jour. Wildlife Mgr. 24:259-265.
786. Hicks, Clifford B. 1964. We can Save our Elms. Popular Mechanics
April 1964.
787. Higgins, D. J. 1959. The Utilization of Glucose Carbon by Five Isolates
of the Fungus *Ceratocystis ulmi*. Ph.D. Dissertation, Ohio State
Univ. i-vit 1-58. (Univ. Microfilms Number 60748).
788. Hildahl, V. and H. R. Wong. 1965. Distribution of the Native Elm
Bark Beetle in Manitoba and Saskatchewan. Proc. Ent. Soc. Manitoba.
21:36-38.
789. Hildahl, V. 1974. Dutch Elm Disease and the Manitoba Situation. Summary
of RCGA National Turfgrass Conference. Pages 36-39.
790. Himelick, E. B. 1962. Recent Research for Control of Dutch Elm Disease.
Proc. Illinois Tech, Forestry Assoc. 5(2):6-9.
791. Himelick, E. B. 1963. Recent Research for Controlling Vascular Diseases
and its Practical Application. Proc. Midwestern Shade Tree Conference.
18:36-43.
792. Himelick, E. B. 1965. Prevention of Root Graft Transmission of Dutch Elm
Disease (Vapam). Arborist's News 30(2):9-13.
793. Himelick, E. B. 1965. Supplementary Procedures for Dutch Elm Disease
Control. Proc. Dutch Elm Disease Conf. 1965. Michigan State Univ.
p. 3-6.

794. Himelick, E. B. and Dan Neely. 1962. Frequency of Root Grafting between City-planted American Elms. *Arborist's News* 27(4):29-31.
795. Himelick, E. B. and Dan Neely. 1962. Grafting of Roots between American Elms in a Municipal Planting. *Park Maintenance* 15(5):53-54.
796. Himelick, E. B. and Dan Neely. 1962. Importance of Root Grafts in Dutch Elm Disease Spread. *American Nurseryman* 115:76-77.
797. Himelick, E. B. and D. Neely. 1962. Prevention of Bark Beetle Development in Undesirable Elms for Control of Dutch Elm Disease. *Plant Disease Reporter* 45:180-184.
798. Himelick, E. B. and D. Neely. 1962. Root-grafting of City-planted American Elms. *Plant Disease Reporter* 46:86-87.
799. Himelick, E. B. and Dan Neely. 1963. Systemic Control of Bark Beetle Colonization of Diseased American Elms. *Plant Dis. Reporter*. 47: 87-88.
800. Himelick, E. B. and D. Neely. 1965. Bioassay using Cellophane to Detect Fungistatic Activity of Compounds Translocated through the Vascular System of Trees. *Plant Disease Reporter* 49:949-953.
801. Himelick, E. B. and Dan Neely. 1965. Prevention of Root Graft Transmission of Dutch Elm Disease. *Arborist's News* 30:9-13.
802. Himelick, E. B. and Dan Neely. 1965. Prevention of Root Graft Transmission of Dutch Elm Disease. *Proc. 20th Midwestern Chapter, International Shade Tree Conference*, p. 49-54.
803. Himelick, E. B., Dan Neely and James H. Tyndall. 1963. Vapam, a Possible Preventive of Root Graft Transmission of the Dutch Elm Disease Fungus. *Plant Disease Reporter*. 47:85-86.
804. Himelick, E. B. et al. 1975. Progress of the Work and Principal Accomplishments. Dutch Elm Disease. *Ann. Rep. Proj. NCR-32*.
805. Hintikka, V. 1974. *Ceratocystis ulmi* in Finland. *Karsteria* 141:32.
806. Hock, W. K. 1970. Systemic Fungicides. *Metro. Hort.* 5(3):1-8. *Colo. State Univ. Ext. Serv.*
807. Hock, W. K. and L. R. Schreiber. 1971. Effect of Adjuvants on the Uptake of Benomyl from Planting Media by American Elm Seedlings. *Plant Disease Reporter* 55(11):971-74.

808. Hock, W. K. and L. R. Schreiber. 1971. Effect of Different Soil Constituents on Uptake of Two Benzimidazole Compounds by American Elm Seedlings. *Phytopath. News* 5(7), Session 14, No. 158. APS Meeting. Philadelphia, Penn. (Speech).
809. Hock, W. K. and L. R. Schreiber. 1971. Effect of Different Soil Constituents on Uptake of Two Benzimidazole Compounds by American Elm Seedlings. *Phytopath.* 61(8):895. (Abstract).
810. Hock, W. K. and L. R. Schreiber. 1971. Evaluation of Benomyl for Control of Dutch Elm Disease. *Plant Disease Reporter* 55:58-60.
811. Hock, W. K., B. R. Roberts and D. E. Wuertz. 1969. A Technique for Rapid Standardization of Conidial Suspensions of *Ceratocystis ulmi*. *Plant Disease Reporter* 53:640-641.
812. Hock, W. K., L. R. Schreiber and B. R. Roberts. 1969. Uptake of Benomyl Fungicide by American Elm Seedlings. *Phytopathology* 60:575. (Abstr.).
813. Hock, W. K., L. R. Schreiber and B. R. Roberts. 1970a. Suppression of Dutch Elm Disease in American Elm Seedlings by Benomyl. *Phytopath.* 60:391-392.
814. Hock, W. K., L. R. Schreiber and B. R. Roberts. 1970b. Factors Influencing Uptake, Concentration, and Persistence of Benomyl in American Elm Seedlings. *Phytopath.* 60:1619-1622.
815. Hoff, Gordon. 1968. Dutch Elm Disease. *Metro Horticulture* 3(1): 1-3. Colorado State Univ. Extension Service.
816. Hoffman, C. H. 1942. Annotated List of Elm Insects in the United States. U.S.D.A. Misc. Publ. 466, 20 pp.
817. Hoffman, C. H. and C. S. Moses. 1940. Mating Habits of *Scolytus multistriatus* and the Dissemination of *Ceratostomella ulmi*. *Jour. Econ. Ent.* 33:818-819.
818. Holmes, F. W. 1954. The Dutch Elm Disease as Investigated by Use of Tissue Cultures, Antibiotics and Peptic Enzymes. Ph.D. Thesis, Cornell University.
819. Holmes, F. W. 1955. Field and Culture Tests of Antibiotics Against *Graphium ulmi*. *Phytopath.* 45:185.
820. Holmes, F. W. 1956. Mapping the Trail of Elm Diseases in Massachusetts. *Res. in Rev.* 5(2):10-11.

821. Holmes, F. W. 1956. Recorded Dutch Elm Disease Distribution in North America as of 1955. Plant Disease Reporter 40(4):351-352.
822. Holmes, F. W. 1957. Recorded Dutch Elm Disease Distribtuion in North America as of 1956. Plant Disease Reporter 41(7):634-635.
823. Holmes, F. W. 1958. Recorded Dutch Elm Disease Distribution in North America as of 1957. Plant Disease Reporter 42(11):1299-1300.
824. Holmes, F. W. 1958. Distribution of Sexual-compatability Strains of *Ceratocystis ulmi* in Massachusetts. Abstr. in Phytopath. 48:263.
825. Holmes, F. W. 1962. Recorded Dutch Elm Disease Distribtuion in North America as of 1961. Plant Disease Reporter 46(10):715-718.
826. Holmes, F. W. 1962. Multidose Injection Apparatus for Dutch Elm Disease Inoculations. Abstr. in Phytopath. 52:924.
827. Holmes, F. W. 1964a. Virulence in *Ceratocystis ulmi* (Buis.) C. Moreau. Abstract in Phytopath. 54:128. (See Holmes, 1965 for Full Article).
828. Holmes, F. W. 1964b. Comparative Resistance of Certain Elm Clones to *Ceratocystis* and *Verticillium* Wilts. Abstr. in Phytopath. 54:896.
829. Holmes, F. W. 1965. A Test Clone of *Ulmus americana* Uniformly Susceptible to *Ceratocystis ulmi*. Abstr. in Phytopath. 55:1284.
830. Holmes, F. W. 1965. Virulence in *Ceratocystis ulmi*. Neth. J. Plant Path. 71:97-112.
831. Holmes, F. W. 1965c. Virulence in *Ceratocystis ulmi*. The Netherlands Jour. Plant Path. 71:97-112, 1 Fig., 3 Tab.
832. Holmes, F. W. 1966. Resistance of *Hemiptelea davidii* to *Ceratocystis ulmi*. Abstr. in Phytopath. 56:881.
833. Holmes, F. W. 1967. Resistance of Certain Elm Clones to *Ceratocystis ulmi* and *Verticillium albo-atrum*. Phytopath. 57:1247-1249.
834. Holmes, F. W. 1968. Research of Elm Trees Resistant to Dutch Elm Disease, Mass. For. and Park Assoc. Conference on Dutch Elm Disease (Oct. 4, 1967). Proceedings 22:9-18.
835. Holmes, F. W. 1969. Formation of Perithecia of *Ceratocystis ulmi* on Synthetic Nutrient Media. Abstr. in Phytopath. 59:1031.

836. Holmes, F. W. 1970. Formation of Perithecia of *Ceratocystis ulmi* on Natural and Synthetic Nutrient Media. *Neth. J. Pl. Path.* 76(3): 129-134.
837. Holmes, F. W. 1971a. Translation of Kerling, L.C.P., and Elgersma, D.M. 1970 Vijftig Jaren Jepziekte. *Vakblad voor Biologen* Dec.: 273-282, 2 Figs. 35 Refs. (Fifty Years of Dutch Elm Disease. 9 pp., Type-written, Phytopathological Translation Archive #165.)
838. Holmes, F. W. 1971b. Vergelijking van Geslacht en Compatibiliteitsgroepen *Ceratocystis ulmi*. Report on Sabbatical Leave, 1970-71 Xeroxed, 3 pp.
839. Holmes, F. W. 1971c. Bibliography of Recent Literature of Elm (*Ulmus* Species). Shade Tree Labs., Univ. Mass. Print-out from Computer Disk-storage, 180 References, Xeroxed.
840. Holmes, F. W. 1971d. Distinction Between Sex and Compatibility in *Ceratocystis ulmi*. *Phytopath.* 62(5):495.
841. Holmes, F. W. 1972. Distinction Between Sex and Compatibility in *Ceratocystis ulmi*. Abstr. in *Phytopath.* 62(5):495.
842. Holmes, F. W. 1973. Pathogenicity of Old Cultures of *Ceratocystis ulmi* and Their Ability to Mate Before and After Re-passage Through Elm Trees. *Phytopath.* 63(2):202.
843. Holmes, F. W. 1973b. Phloem Necrosis--Additional Threats to the Elm. Mass. Tree Wardens, Arborists and Utilities Conference, Proceedings (Mar. 12-16, 1973):61-72.
844. Holmes, F. W. 1973c. Sequential Immersion an Alternative Method to Adjacent Transfer for Obtaining Perithecia of *Ceratocystis ulmi*. Second International Congress of Plant Pathology Abstracts (9-73): 0697.
845. Holmes, F. W. 1974a. Benlate and Dutch Elm Disease. *Univ. Mass. Ext. Serv. Tree News* (April 1974):4 pp.
846. Holmes, F. W. 1974b. Benlate and Dutch Elm Disease. *Tree Magazine* April/June 1974, 33(2):28-29.
847. Holmes, F. W. 1974c. Progress Reports - Dutch Elm Disease. Mimeographed, 3 pp. each (Jan. 1, 1974, June 1, 1974, Sept. 1, 1974):9 pp.

848. Holmes, F. W. 1974d. Pathogenicity to Belgian Elm of a Unisexual Male Culture of *Ceratocystis ulmi*. Abstr. Pro. Am. Phytopath. Soc. 1:136.
849. Holmes, F. W. 1975a. Shade Tree Research: Dutch Elm Disease (and Other than Dutch Elm Disease. Tree Wardens, Arborists and Utilities Conference Proceedings Mar. 16-20, 1975:33-42.
850. Holmes, F. W. 1975b. Current Information on Central Measures for Dutch Elm Disease. Tree Wardens, Arborists and Utilities Conference Proceedings Mar. 16-20, 1975:79-90.
851. Holmes, F. W. 1975c. Progress Report - Dutch Elm Disease. Mimeographed. 3 pp. Jan. 1, 1975.
852. Holmes, F. W. 1975d. Distinction Between Sex and Compatibility in *Ceratocystis ulmi*, as Shown by Unisexual Male Cultures. Mycologia (in press).
853. Holmes, F. W. and J. S. Demaradzki. 1960. *Hemiptelea* and the Dutch Elm Disease. Rep. Mass. Agri. Exp. Sta. 1959-1960. Bulletin 524:34.
854. Holmes, F. W. and M. A. McKenzie. 1973. Progress Reports - Dutch Elm Disease. Mimeographed, 3 pp. each Jan. 1, 1973, June 1, 1973, Sept. 1, 1973:9 pp.
855. Holmes, F. W., H. M. Heybroek and J. N. Gibbs. 1972 Aggressiveness in *Ceratocystis ulmi*. Phytopath. 62(8):939.
856. Hopkins, A. D. 1893. Catalog of W. Va. Scolytidae and Their Enemies. W. Va. Agr. Exp. Sta. Bull. 31, Vol 3:121-168. 1893.
857. Horsfall, J. G. 1945. Fungicides and Their Action. Chronica Bot. Co. 1945.
858. Horsfall, J. G. and G. A. Zentmyer. 1941. Chemotherapy for Vascular Diseases of Trees. Proc. Nat. Shade Tree Conf. 17:7-15.
859. Horsfall, J. G. and G. A. Zentmyer. 1942. Antidoting the Toxins of Plant Diseases. Abstr. in Phytopath. 32:22.
860. Horsfall, J. G., E. M. Stoddard and A. E. Dimond. 1947. Chemical Therapy for Plant Diseases. Agric. Chem. 2:28-31.
861. Hostermann, G. and M. Noack. 1925. Ueber das Ulmensterben am Unteren Rhein. (The Dying-off of the Elms on the Lower Rhein). Mitt. Deut. Pendlol. Gos. 35:287-9.

862. Hostermann, G. and M. Noack. 1925. Zum Ulmensterben. (On the Elm Disease). Gartenwelt. 29:549-50.
863. Houben, J. and H. W. Wollenweber. 1929. Hexylresorcin und Phenylathylresocion Gegen Pflanzinpathogene Pilze. (Hexylresorcin and Phenylathylresocion as a Fungicide). Biochem. Ztschr. 204:448-55.
864. Houtzagers, G. 1924. De Sterfte Onder de Boomen. (The Tree Mortality). Tijdschr. Nederl. Heidemaatsch. 36:258-65.
865. Houtzagers, G. 1927. De Iepenziekte en Haar Voorkomen op Andere Houtsoorten. (The Elm Disease and its Occurrence on Other Kinds of Wood). Tijdschr. Nederl. Heidemaatsch. 39:177-80.
866. Howard, R. J. and D. P. Maxwell. 1975. Cytology of *Ceratocystis ulmi*. Phytopath. 65(7):816-818.
867. Hoyt, A. S. 1944. Dutch Elm Disease. Nat'l Plant Bd. Ann. Meeting Min. 19:14-15.
868. Hubbes, M. and R. Pomerleau. 1969. Factors in Elm Wood Responsible for the Production of Coremia by *Ceratocystis ulmi*. Can. Jour. Bot. 47:1303-1306.
869. Hubert, E. E. 1931. An Outline of Forest Pathology. John Wiley and Sons, Inc. N.Y. 543 pp.
870. Humphrey, Henry B. and Jessie I. Wood. 1935. *Ulmus* Spp. Elm. Plant Disease Reporter Supplement 86:70.
871. Hunt, J. 1956. Taxonomy of the Genus *Ceratocystis*. Lloydia 19:1-59.
872. Hunt, L. B. 1960. Songbird Breeding Populations in DDT-Sprayed Dutch Elm Communities. Jour. Wildlife Mgt. 24:139-146.
873. Hunt, L. B. 1968. Songbirds and Insecticides in a Suburban Elm Environment. Abstr. of Thesis, in Dissert. Abstr. 1968, University of Wisconsin.
874. Hurlander, L. 1931. Frufroost die Ursache des ulmensterbens? (Early Frost and the Cause of the Elm Disease?) Gartenwelt 75:114 Illustrated.
875. Husain, A. and A. E. Dimond. 1958. (The Function of Extracellular Enzymes of Dutch Elm Disease Pathogen). Proc. Natl. Acad. Sci. 44(6):594-601.

876. Ilnitzky, R. 1934. Die Spatzen und das Ulmensterben. (Sparrows and the Elm Disease). Gartenflora 83:76-7.
877. Iowa State University. 1967. Time for Decision; a Movie on Dutch Elm Disease Produced by the Iowa State University Film Production Unit.
878. Irish, C. F. 1930. Our Elm Trees are Endangered by the European Elm Disease. Poster of Chas. F. Irish, Co., of Ohio, Illustrated 3.J1 1930.
879. Irish, C. F. 1935. The Dutch Elm Disease. Parks and Recreation 18: 217-21, Illustrated.
880. Irish, C. F. 1937. Present Status of Dutch Elm Disease in United States. Parks and Recreation 20:332-3.
881. Jacot, A. P. 1934. Acarina as Possible Vectors of the Dutch Elm Disease. J. Econ. Ent. 27(4):858-859.
882. Jacot, A. P. 1936. Three Possible Mite Vectors of the Dutch Elm Disease. Ann. Ent. Soc. America 29:627-635.
883. Jacques, J. E. 1944. Un Chancre de l'Orme de Sibirie (*Ulmus pumila*) Cause par *Nectria cinnabarina*. Ann. Ass. Canad. Franc. Sci. 10:89.
884. Janutolo, D. B. et al. 1974. Effect of Fungitoxicants on the Viability of *Ceratocystis ulmi* Conidia. Abstr. Proc. Am. Phytopath. Soc. 1:151.
885. Jeffers, J. N. R. 1972. Dutch Elm Disease and Botanical Variation in English Elm. Nature 236:407-408.
886. Jobling, J. and A. F. Mitchell. 1974. Field Recognition of British Elms. Book1. For. Comm. 42, (in press).
887. Johnson, E. M. 1937. Distribtuion of *Cephalosporium* and *Verticillium* of Elm in Massachusetts. Plant Disease Reporter 21(3):58-9.
888. Jones, M. E., Jr. 1971. Electron Microscopy of Host Tissue Deterioration in Dutch Elm Disease. Ph.D. Thesis, Iowa State University Library. 164 p.
889. Jones, Marion E., Jr. 1971. The Sapwood Discoloration Phenomena in Dutch Elm Disease. Dissertation (May, Iowa State Univ.) in Phytopath. News 4(12):1100.
890. Jones, T. H. 1939. The European Elm Bark Beetle. USDA Leaflet 185.

891. Jones, T. H. and C. S. Moses. 1943. Isolation of *Ceratostomella ulmi* from Insects Attracted to Felled Elm Trees. J. Ag. Res. 66:77-85.
892. Jones, T. W. and G. F. Gregory. 1971. An Apparatus for Pressure Injection of Solutions into Trees. USDA Forest Service Research Paper NE-233.
893. Jones, T. W. et al. 1973. Pressure Injection of Solubilized Benomyl for Prevention and Cure of Oak Wilt. USFS Res Note NE-171.
894. Jordan, E. 1935. Zur Ulmenkrankheit. (The Elm Disease). Blumen. u Pflanzenb. Vereinigt Gartenw. 39:449-50.
895. Jorgenson, Erik. 1962a. The Dutch Elm Disease - What Can be Done About it? Canadian Audobon Mag. Nov.-Dec.
896. Jorgenson, Erik. 1962b. Varsity Controls Dutch Elm Disease. The Annual Ring, Faculty of Forestry, Univ. of Toronto. Page 14.
897. Jorgenson, E. 1962c. (Unpublished). Recommendations for the Initiation of an Elm Preservation Program in a Municipality. Mimeo Report.
898. Jorgenson, E. 1963. Cost and Economy of a Dutch Elm Disease Control Program. Mimeo Report, 1st. Symposium on Shade Trees, Toronto.
899. Jorgenson, E. 1967. In J. W. Peacock (ed.) Proceedings Dutch Elm Disease Meeting. U.S.F.S. Delaware, Ohio. 69 pp.
900. Jorgenson, E. 1974. Dutch Elm Disease Impact on the Urban Forestry Situation. Summary of R.C.G.A. National Turfgrass Conference. Pages 46-47.
901. Jorgenson, E. and E. S. Kondo. 1967. Measurement of Gas Exchange in Woody Plants. Nature Lond. 213:413-414.
902. Jorstad, I. 1930. Innberetning fra Statsmykolog Ivar Jorstad om Soppsykdommer pa Skogtraerne i Arene 1926-30. (Fungus Diseases of Forest Trees for the Years 1926-30 by States Mycologist, Ivar Jorstad). Breten. Norske. Skogv. 1930:78-96. See p. 98.
903. Jorstad, I. 1936. Melding om Soppsykodommer pa Skogtraerne i Arene 1931-35. (Report on Fungus Diseases of Forest Trees in the Years 1931-35). Breten. Norske. Skogv. 1935:83-100.
904. Kaarik, A. 1960. Growth and Sporulation of *Ophiostoma* and Some Other Blueing Fungi on Synthetic Media. Symb. Bot. Upsaliens 16(3):1-168.

905. Kailides, D. S. 1969. Dutch Elm Disease in Greece. *Das. Chron.* 11(7): 7-14.
906. Kais, A. G., E. B. Smalley and A. J. Riker. 1962. Environment and Development of Dutch Elm Disease. *Phytopath.* 52:1191-1195.
907. Kaiser, P. 1931. Das Ulmensterben. (The Die-back of Elms). *Gartenflora* 80(11):369.
908. Kalandra, A. and A. Pfeffer. 1935. (A Contribution to the Study of Elm Graphiosis). Reprint Lesn. Prace 14:1-17.
909. Kalandra, A. and A. Pfeffer. 1938. Dulezitejsi a Pozoruhodnejši Poskozeni Choroby a Skuder Lesnich Drevin v Letech 1936-36 V Československu. (The Most Important and Noteworthy Troubles, Diseases and Pests of Forest Trees in Czechoslovakia in the Years 1935-36). *Ochr. Rost.* XIV:24-33.
910. Kammeraad, J. W. and R. Brewer. 1963. Dispersal Rate and Elm Density as Factors in the Occurrence of Dutch Elm Disease. *Amer. Midl. Nat.* 70:159-163.
911. Kansas State Univ. 1970. Dutch Elm Disease and its Control in Kansas. *Agr. Exp. Sta. Bull.* 434.
912. Kaston, B. J. 1936. The Morphology of the Elm Bark Beetle *Hylurgopinus rufipes* (Eichhoff). *Conn. Agr. Exp. Sta. Bull.*
913. Kaston, B. J. 1937. Notes on Hymenopterous Parasites of Elm Insects in Connecticut. *Conn. Agr. Expt. Sta. Bull.* 396:351-361.
914. Kaston, B. J. 1938. Check List of Elm Insects. *Conn. Agr. Expt. Sta. Bull.* 408:235-242.
915. Kaston, B. J. 1939. The Native Elm Bark Beetle (*Hylurgopinus rufipes* Eichhoff) in Connecticut. *Conn. Agr. Exp. Sta. Bulletin* 420. pp 39.
916. Kaston, B. J. and W. B. Becker, 1935. *Spathius canadensis* Ashm., a parasite of *Hylurgopinus rufipes* (Eich.). *Jour. Econ. Ent.* 29:807.
917. Kaston, B. J. and D. S. Riggs. 1937. Studies on the Larvae of the Native Elm Bark Beetle. *Jour. Econ. Ent.* 30:98-108.
918. Kaston, B. J. and D. S. Riggs. 1938. On Certain Habits of Elm Bark Beetles. *Jour. Econ. Ent.* 31:467-469.

919. Kauffman, E. 1936. Save the Elms. It Can be Done, Says the National Conference on Dutch Elm Disease, With Adequate and Unrestricted Appropriations. Amer. For. 42:22-3, 42, Illustrated.
920. Kavina, K. 1933. Jilmova Epidemie. (On the Elm Disease). Veda Prirodni 14:97-102, Illus.
921. Kellerman, K. R. 1934. Control Work on the Dutch Elm Disease in Connecticut, New York and New Jersey for the Winter and Springs 1933-34. USDA Bur. Entom., Div. Plant Dis. Erad. and Control. 3 pp. Mimeo.
922. Kellerman, K. F. 1934. Look for the Dutch Elm Disease. Plant Disease Reporter 18:113-114.
923. Kellerman, K. R. 1934. Status of the Dutch Elm Disease. Plant Disease Reporter 18:101.
924. Kellerman, K. R. 1934. Summary of the Dutch Elm Disease Situation in the United States as of June 20, 1934. USDA Bur. of Entom. and Plant Quar. Div. of Plant Disease Erad. 3 pp. Mimeo.
925. Kelley, M. C. 1935. The Anakim of New England Elms. Amer. For. 41:22.
926. Kelman, A. 1963. Dutch Elm Disease in North Carolina. Plant Disease Reporter 47(2):154.
927. Kelsheimer, E. G. 1935. Elm Wilt Caused by *Verticillium*. Plant Disease Reporter Suppl. 90:100.
928. Kelsheimer, E. G. 1936. Elm Wilt Caused by *Verticillium*. Plant Disease Reporter Suppl. 96:259.
929. Kelsheimer, E. G. and L. M. Fenner. 1939. Number of Suspected and Confirmed Samples of Dutch Elm Disease in 1937. Plant Disease Reporter Suppl. 110:255.
930. Kelsheimer, E. G. and C. May. 1940. *Verticillium* Wilt of Elm. Plant Disease Reporter 23:282-284.
931. Kelsheimer, E. G. and C. May. 1940b. Prevalence of Elm Die-back Caused by *Dothiorella ulmi*. Plant Disease Reporter 24:369-370.
932. Kelsheimer, E. G. et al. 1939. Number of Elm Specimens Cultured and Percentage Yeilding *Ceratostomella ulmi*, 1930-1938. Plant Disease Reporter 23:182-183.
933. Kenealy, J. C. 1945. The Dutch Elm Disease. For. Leaves 34, 1944 (1,8).

934. Kennedy, B. H. 1970. *Dendrosoter protuberans* (Hymenoptera: Braconidae) an Introduced Larval Parasite of *Scolytus multistriatus*. Ann. Entomol. Soc. Amer. 63:351-358.
935. Kennedy, B. H. and J. R. Galford. 1971. Development of *Dendrosoter protuberans* (Nees) on Larvae of *Scolytus multistriatus* (Marsham) on an Artificial Medium. Proc. North Cent. Branch, Entomol. Soc. of America.
936. Kennedy, B. H. and J. R. Galford. 1972. Development of *Dendrosoter protuberans* (Hymenoptera: Braconidae) on Larvae of the Smaller European Elm Bark Beetle Being Reared on an Artificial Medium. Scientific Notes 65(3):757-759.
937. Kerling, L. C. P. 1955. Reactions of Elm Wood to Attacks of *Ophiostoma ulmi* (Buis.). Nannf. Acta. Bot. Neerl. 4:398-403.
938. Kessler, K. J. 1966. Xylem Sap as a Growth Medium for Four Tree Wilt Fungi. Phytopath. 56:1165-1169.
939. Kilgore, W. W. and E. R. White. 1970. Decomposition of the Systemic Fungicide 1991 (Benlate). Environ. Contam. Toxicol. 5(1):67-69.
940. King, E. J. et al. 1974. Preliminary Scanning Electron Microscopy of *Ceratocystis ulmi*. Abstr. Proc. Am. Phytopath. Soc. 1:137.
941. Kireev-Varshavskii, E. P. 1958. (A Return to the Question of Dutch Elm Disease Control). Lesn. Khoz. 12:43-44.
942. Kleiner, G. F. and J. W. Peacock. 1971. Amino Acids in the Haemolymph of Smaller European Elm Bark Beetle Larvae *Scolytus multistriatus* (Marsham) (Coleoptera: Scolytidae) Ohio Jour. Sci. 71:36-43.
943. Knoll, W. 1933. Eine Beobachtung in Bezug auf die Ulmenkrankheit. (An Observation in Regard to the Elm Disease.) Gartenwelt 37:627, Dec. 22, 1933.
944. Knull, J. N. 1934. Scouting for Elm Scolytids. Jour. Econ. Ent. 27:365-366, Illustrated.
945. Kock, G. 1928. Ueber das Ulmensterben und die Bekämpfung von Baumkrankheiten Durch Baumimpfungen. (On the Elm Disease and the Control of Tree Diseases by Injections). Gartenztg. Oester. Gartenb.-Ges. (Vienna) 1928:107-8.
946. Kondo, E. S. 1966. Host-parasite Relationships in the Dutch Elm Disease. Thesis, M. Sc. F., University of Toronto.

947. Kondo, E. S. 1966. Dutch Elm Disease Affects Globe and Asiatic Elms. Ontario Shade Tree Council Newsletter Vol. 1, No. 3. 1966.
948. Kondo, E. S. 1970. Studies on the Physiology of *Ceratocystis ulmi* (Buism.) C. Moreau and its Hosts (*Ulmus* spp.) Ph.D. Thesis, Univ. Toronto, Toronto, Ont.
949. Kondo, E. S. 1971. Occurrence of Perithecia of *Ceratocystis ulmi* in Ontario. Can. For. Serv. Bi-monthly Res. Notes 27(1):5.
950. Kondo, E. S. 1972. A Method for Introducing Water-Soluble chemicals into Mature Elms. Can. For. Serv. Info. Rep. O-X-171.
951. Kondo, E. S. 1974. Summary of Recent Dutch Elm Disease Research. Summary of R. C. G. A. National Turfgrass Conference. Pages 43-45.
952. Kondo, E. S. and G. D. Huntley. 1973. Smaller European Elm Bark Beetle Found in Ottawa. Bi-mon. Res. Notes 29(5):29.
953. Kondo, E. S. and G. D. Huntley. 1973. Root-injection Field Trials of MBC-phosphate in 1972 for Dutch Elm Disease Control. Can. For. Serv. Info. Rep. O-X-182.
954. Kondo, E. S. and G. D. Huntley. 1974. A Large Capacity Injection System for Chemical Solutions in Dutch Elm Disease Control. Great Lakes For. Res. Cent. Info. Rep. O-X-192.
955. Kondo, E. S. and G. D. Huntley. 1974. An Index for Rating Trees with Dutch Elm Disease. Great Lakes For. Res. Cent. Info. Rep. O-X-201.
956. Kondo, E. S. and G. D. Huntley. 1975. Calculation of Injection Dosages and Prediction of Injection Periods for Flexibility in Effective Control of Dutch Elm Disease with MBC-Phosphate Solution. Can. For. Serv. Sault. Ste. Marie, Ont. Report O-X-237. 8 p.
957. Kondo, E. S. and G. D. Huntley. 1975. A Disposable Trunk and Root-Flare Injector Head for Low-pressure Injection of Chemical Solutions into Trees. Can. For. Serv. Sault, Ste. Marie, Ont. Report O-X-235. 5 p.
958. Kondo, E. S. et al. 1972. Progress Report on Dutch Elm Disease. For. Res. Cent., Vol. 2, No. 6.
959. Kondo, E. S. et al. 1973. Salts of Methyl - 2 - Benzimidazole Carbamate (MBC) and Assessment of Their Potential in Dutch Elm Disease Control. Can. J. For. Res. 3(4):548-555.

960. Konig, C. D. 1927. Ulmensterben in Hamburg. (The Elm Disease in Hamburg). Mollers Deut. Gart.-Ztg. 42:133-34, Illus. on page 132-33.
961. Kother, H. 1930. Dan Ulmensterben Geht Weiter. (The Die-back of Elm Spreads Further). Gartenwelt. 34(51):702.
962. Kramer, C. L. and H. E. Thompson. 1962. Dutch Elm Disease in Kansas in 1961. Plant Disease Reporter. 46:189.
963. Krause, C. R. 1975. Progress in Fingerprinting Shade Trees. In. Proceedings Plant Fingerprinting Symposium, Hort. Res. Inst. 1-3.
964. Krause, C. R. and C. L. Wilson. 1972. Fine Structure of *Ceratocystis ulmi* in Elm Wood. Phytopath. 62(11):1253-1256.
965. Krijthe, N. 1940. Verslag Over de Werkzaamheden Voor het Iepeniekte-Comite Verricht an het Labortorium Voor Erfelijkheidsleer in 1939. Iepenziekte-Comite Meded. 34:9-18.
966. Krijthe, N. and Johanna Went. 1938. Inoculaties van Iepenbastaarden Verricht in 1938. Tijdschr. Plziekt. 45:71-74.
967. Krijthe, N. and Johanna Went. 1940. Inoculaties van Iepenbastaarden Verricht in 1939. Iep.-Comite Meded. 34:19-22.
968. Kruepper, O. 1932. Die Wahre Ursache des Grossen Ulmensterbens: Richtigstellung der Ansichten des Herrn Otte...(The True Casue of the Great Elm Disease. Putting Straight the Opinions of Otte). Mollers. Deut. Gart.-Ztg. 47:428-9.
969. Kruepper, O. 1933. Zum Kapital Ulmensterben. (The Disasterous Elm Disease). Mollers Deut. Gart.-Ztg. 48:208.
970. Krussmann, G. 1930. Neuheit: *Ulmus gaujardii*. (The Latest Thing: *Ulmus gaujardii*). Gartenwelt. 34:692.
971. Kuntz, J. E. 1964. Forest Disease Control: Indirect Measures. FAO/IUFRO Symposium on Internationally Dangerous Forest Tree Diseases and Insects. Oxford. 10 p.
- ✓972. Kuntz, J. E. 1964. Vascular Wilt Diseases of Forest and Shade Trees. FAO/IUFRO Symposium on Internationally Dangerous Forest Tree Diseases and Insects. Oxford. 8 p.
973. Kuntz, J. E. 1965. Forest Disease Control, p. 134-137. Part II. Control of Forest Insects and Diseases. In FAO/IUFRO Symposium on Internationally Dangerous Forest Diseases and Insects. Unasylva. 19(3):97-156.

- 974. Kuntz, J. E. and E. B. Smalley. 1964. Prevention of Root Graft Transmission of the Oak Wilt and the Dutch Elm Diseases With Soil Fumigants. 18th Ann. Pesticide Conf. With Industry Jan. 8-9, 1964.
- 975. Kuntz, J. E. and E. B. Smalley. 1964. Soil Fumigants: New Tool for Tree Disease Control - or - Cut the Graft and Save Your Trees. Hoard's Dairyman.
- 976. Kuntz, J. E. and V. M. G. Nair. 1968. Control of Forest Tree Diseases With Herbicides. Proc. North Central Weed Control Conference. 3 p.
- 977. Kurtzman, R. H., Jr. 1962. Anti-adenosine Triphosphate from *Ceratocystis ulmi*. Abstr. 141st Meeting Am. Chem. Soc.
- 978. Kurtzman, R. H., Jr. 1962. Effects of a Heat Stable Constituent of *Ceratocystis ulmi* Culture Filtrate on ATP and Water Movement. Abstr. in Phytopath. 52:924.
- 979. Kurtzman, R. H., Jr. 1964. An Adenosine Triphosphate-binding Substance from *Ceratocystis ulmi*. Phytopath. 54:1386-1388.
- 980. Kurtzman, R. H., Jr. 1965. Physiological Comparison of Metabolic Inhibitors With a Culture Filtrate of *Ceratocystis ulmi*. Abstr. in Phytopath. 55:1065.
- 981. Landin, J. M. et al. 1969. Biology and Feeding Habits of the Smaller European Elm Bark Beetle on American Elm Trees Treated With Bidrin. Jour. Econ. Ent. 62:640-643.
- 982. Landis, W. R. and J. H. Hart. 1968. Respiratory Changes in *Ceratocystis ulmi* Infected *Ulmus americana*. Abstr. in Phytopath. 58:1057.
- 983. Landis, W. R. and J. H. Hart. 1972. Physiological Changes in Pathogen Free Tissue of *Ulmus americana* Induced by *Ceratocystis ulmi*. Phytopath. 62(8):909-914.
- 984. Lanier, G. N. Dr. 1975. Bright Prospects for Control of Dutch Elm Disease. New York Times Mar. 16, 1963.
- 985. LaPerriere, L. R. and W. A. Howard. 1970. Applications of Aerial Infrared Imagery to Research on the Dutch Elm Disease. Council of Planning Librarians Exchange Bibliography #150, 25 pp.
- 986. Latrell, E. S. 1950. *Bosryospheria* Stem Canker of Elm. Plant Disease Reporter 34:138-139.
- 987. Laut, John G. et al. 1969. The Recurrence of Dutch Elm Disease in Colorado. Plant Disease Reporter 53:253.

988. Laut, J. G. et al. 1972. Distribution of Dutch Elm Disease in Colorado - 1971. *Plant Disease Reporter* 56(10):912-913.
989. Laut, J. G. et al. 1973. Dutch Elm Disease in Colorado - 1972. *Plant Disease Reporter* 57(6):511-513.
990. Laut, J. G. et al. 1974. Dutch Elm Disease in Colorado, 1973. *Plant Disease Reporter* 58(6):571-572.
991. Leach, J. G. 1935. Insects in Relation to Plant Diseases. *Bot. Rev.* 1:448-486.
992. Leach, J. G. 1940a. Insect Transmission of Plant Diseases. Pages 224-234 of McGraw Hill Inc. New York. 615 pp.
993. Leach, J. G. 1940b. Fungi Associated with *Scolytus multistriatus* in Regions where *Ceratocystis ulmi* Has Not Been Found. *Abstr. in Phytopath.* 30:15.
994. Lechevalier, H. et al. 1953. Candicidin, a New Antifungal Antibiotic. *Mycologia* 45:155-171.
995. Ledebor, M. S. J. 1934. Physiologische Onderzoekingen over *Ceratomyces ulmi* (Schwarz) Buisman *Path. Lab. Willie Comm. Scholten Baarn*:1-95.
996. Lee, M. J. T. and D. T. Lester. 1974. Floral Receptivity in American Elm. *Can. J. For. Res.* 4(13):416-417.
997. Lekander, B. et al. 1951. Om Almsjukan Sant Red och Anvisningar for Less Hekampade Flygbl. *Skogsforskiningsinst, Stocka*, 65:8.
998. Lendner, A. 1932. (The Elm Disease at Geneva). *Verhandl. Schweiz. Naturforsch. Gessellsch.* 113:371-372.
999. Lendner, A. 1932. La Maladie des Ormeaux. (The Disease of the Elms). *Rev. Hort. Suisse, Ann.* 5:241-7, Nov., 1932.
1000. Leonard, Bill. 1967. Is Dutch Elm Disease Really Russian? *Brookings S. D. Register in Arborist's News* 32(8):63-64.
1001. Lepik, E. 1932. Metsanduslikke taimekaitse kusimusi. (Some Questions Relating to Plant Protection in the Forest). *Tartu Ulikooli Taimehaiguste-Katsejaama Teated.* 12:1-12.

1002. Lepik, E. 1940. Estonia. The Elm Disease in the Country. Int. Bull. Pl. Prot. XIV. 2:1940.
1003. Lester, Donald T. 1971. Self-compatibility and Inbreeding Depression in American Elm. Forest Science 17(3):321.
1004. Lester, D. T. and E. B. Smalley. 1969. Prospects for Elm Breeding in Wisconsin. Proc. 6th Central Forest Tree Improv. Conf. "1968".
1005. Lester, D. T. and E. B. Smalley. 1972. Response of Backcross Hybrids and Three-species Combinations of *Ulmus pumila*, *U. japonica* and *U. rubra* to Inoculation With *Ceratocystis ulmi*. Phytopath. 62(8): 845-848.
1006. Lester, D. T. and E. B. Smalley. 1972. Response of *Ulmus pumila* and *U. pumila* X *rubra* Hybrids to Inoculation With *Ceratocystis ulmi*. Phytopathology 62(8):848-852.
1007. Lester, D. T. and E. B. Smalley. 1972. Variation in Ornamental Traits and Disease Resistance Among Crosses of *Ulmus pumila*, *U. rubra*, and Putative Natural Hybrids. Silvae Genetica 21:193-197.
1008. Lester, D. T. and E. B. Smalley. 1974. Interspecific Hybridization for Commercial Production of Disease Resistant Elms. Proc. 8th Central States for Tree Improv. Conf. Aug., 1974:73-75.
1009. Liese, J. 1933. Nochmals das Ulmensterben in den Auereviren. (The Elm Disease in the Aue Forest Preserves Once More). Deut. Forst.-Ztg. 47:394-5.
1010. Liese, J. 1952. Pflanzenphysiologische Betrachtungen zum Ulmensterben. Arch. Forstw. 1(1-2):59-70.
1011. Liese, J. and B. Butovitch. 1931. Das Ulmensterben in den Auerevieren, Seine Ursache und Seine Bekämpfung. (The Elm Disease in the Aue Forest Preserves, its Cause and Control). Deut. Forst.-Ztg. 46: 111-16, Illus.
1012. Liming, F. G. 1934. A Preliminary Study of the Length of the Open Vessels in the Branches of American Elm. Ohio Jour. Sci. 34:415-419.
1013. Liming, O. N. 1931. The Dutch Elm Disease in America. Ohio Agr. Exp. Sta. Ohio For. News 12:3-4, Feb. 1931.
1014. Liming, O. N. 1932. Present Status of the Dutch Elm Disease. Abstr. in Phytopath. 22:17.

1015. Liming, O. N. 1932. The Dutch Elm Disease in America. Nat. Shade Tree Conf. 8:111-113.
1016. Liming, O. N. 1933. Elm Diseases in America. Abstr. in Phytopath 23:21.
1017. Liming, O. N. 1933. Some Facts About the Dutch Elm Disease. Amer. Nurs. No. 4. 57:56, 66.
1018. Liming, O. N. 1934. The Dutch Elm Disease Eradication Program in the United States. Nat. Shade Tree Conf. 10:67-72.
1019. Liming, O. N. 1937. The Dutch Elm Disease Eradication Program - Objectives Methods, and Results. Plant Disease Reporter Suppl. 99:18-25.
1020. Liming, O. N., Editor. 1948. Elm Bark Beetle Conference Committee Report on D.E.D. Control. Trees 8(3):7-8, 18, 20, 1948.
1021. Liming, O. N., E. G. Rex and K. Layton. 1951. Effects of a Source of Heavy Infection on the Developments of Dutch Elm Disease in a Community Phytopath. 41:146-151.
1022. Lincoln, A. Charles. 1967. Insect Research at the Delaware Laboratory. Trees Magazine 28(2).
1023. Lincoln, A. C. 1967. An Evaluation of Bidrin for Control of *Scolytus multistriatus*, the Primary Vector of *Ceratocystis ulmi*. Ph.D. Thesis State Univ. Coll. For. at Syracuse Univ. 165 p.
1024. Lincoln, A. Charles. 1969. The Dutch Elm Disease Research Program in the U.S. Forest Service. Tree Wardens, Arborists and Utilities Conf. Proc. pp. 138-147.
1025. Lincoln, A. Charles. 1970. Can Cities Continue to Afford Elm Trees? Northeastern Forest Experiment Station (USFS) Abstr.
1026. Lincoln, A. Charles and Lawrence R. Schreiber. The Dutch Elm Disease and its Control. Agriculture Information Bulletin No. 193.
1027. Linden, Graf von and Lydia Zenneck. 1927. Erwiderung auf die Kritischen Bemerkungen von Brussoff zum Ulmensterben. Centr. Bakt. II. 71:300-302.
1028. Linden, Graf von and Lydia Zenneck. 1927. Untersuchungen uber das Ulmensterben in den Bestanden der Stadtischen Gartenverwaltung der Stadt Bonn Under Andenur Orte. Centr. Bact. II. 69:340-351.

1029. Linder, D. H. 1931. Some Diseases of Elm Trees. Missouri Bot. Gard. Bulletin 19:61-9, Illus.
1030. Lindfores, T. 1931. Almdoden. (Elm Diseases). Lustgarden 12:75-83, Illustrated.
1031. Lindsay, F. W. 1976. Injecting Our Elms. Forestry '76. 45.
1032. Linz, C. L. 1934. Elm Disease Fight to go on. Flor. Exch. No. 24 83:29.
1033. Lloyd, E. H., Jr. 1975. Dutch Elm Disease in North Dakota in 1975. N.C.R. 32 Report.
1034. Lloyd, E. H. and Dean McBride. 1971. Dutch Elm Disease. North Dakota State Univ. Circular PP-324. 5 pp.
1035. Lohman, M. L. and A. J. Watson. 1943. Identity and Host Relations of *Nectria* Species Associated with Diseases of Hardwoods in the Eastern States. Lloydia 6:77-108.
1036. Lustner, G. and T. Gante. 1935. Bererckungen zum Ulmensterben. Zeitschr. Pflanzenrk. 45:79-97.
1037. Lloyd, E. H., Jr. 1975. Dutch Elm Disease in North Dakota in 1975. N.C.R. 32 Report.
1038. MacCallum, B. D. 1922. Some Wood-staining Fungi. Trans. Brit. Mycol. Soc. 7:231-236.
1039. MacDonald, W. L. 1970. Electron Microscope Observations of *Ceratocystis ulmi*-infected Elm. Abstr. in Phytopath. 60:6.
1040. MacDonald, W. L. and H. S. McNabb, Jr. 1970. Fine-Structural Observations of the Growth of *Ceratocystis ulmi* in Elm Xylem Tissue. BioScience 20:1060-1061.
1041. MacDonald, W. L. and H. S. McNabb, Jr. 1974. Electron Microscope Observations of *Ceratocystis ulmi*-inducted Tylosis Development in *Ulmus*. Bur J. For. Path. 4(1):2-10.
1042. MacHardy, W. E. and C. H. Beckman. 1973. Water Relations in American Elm Infected With *Ceratocystis ulmi*. Phytopath. 63(1):98:103.
1043. MacHardy, W. E. and C. H. Beckman. 1974. The Occurence and Cause of Cavitation of American Elm Shoot Nodal Tissue Infected by *Ceratocystis ulmi*. Phytopath. 64(3):290-293.

1044. Magasi, L. P. 1964. Maritime Provinces, Forest Disease Conditions.
In Annual Report of the Forest Insect and Disease Survey, 1963.
Can. Dept. For., For. Ent. and Path. Branch, Ottawa.
1045. Magasi, L. P. 1975. Identification of *Ceratocystis ulmi* by coremia.
Bi-monthly Res. Notes 31(2):13.
1046. Maksimovic, M. et al. 1971. (A Contribution to the Study of Elm
Die-back Caused by Dutch Elm Disease in the Region of Forest Farm
Bjelovar). Zatista. Bilja #112-113:1-20.
1047. Malaquin, A. 1923. La Maladie des Ormes. (The Elm Disease). Renaissance
Agr. 4:91-4.
1048. Manka K. 1953. O Przebiegu Holenderskiej Choroby Wiazow (*Ceratostomella
ulmi* (Schwarz.) Buisman) na Terenie Miasta Poznania. Acta. Soc.
Bot. Polon. 22(2):355-78.
1049. Marchal, E. 1928. Resume des Observations Phytopathologiques Faites de
1920 a 1926. Ann. Stat. Agron. de l'Etat. Gembloux, Bull. 2:115-126.
1050. Marchal, E. 1929. Apropos de la "Maladie de l'Orme". Soc. Centr. For.
Belg. Bull. 36:169-172.
1051. Marchal, E. 1930. Toujours la "Maladie" de l'Orme. (Again the Elm
Disease). Bull. Soc. Centr. For., Belgique 33 (Ann. 37):21-3.
1052. Marchal, E. 1932. Recherches et Observations Effectuees a la Station
de Phytopathologie de l'Etat Pendant la Periode 1927-1931. (Research
and Observations Carried out at **** During the Period ****) Bull.
Inst. Agron. Stat. Rech. Gembloux. 1:164-74.
1053. Marchal, E. 1933. Le Probleme de l'Immunité en Pathologie Vegetale.
(The Problem of Plant Immunity in Plant Pathology). Ann. Gembloux.
39:381-95.
1054. Marchal, E. 1934. Observations et Recherches Effectuees a la Station de
Phytopathologie de l'Etat, Pendant l'Annee 1933. (Research and
Observations Carried out at **** During the Year ****). Bull.
Inst. Agron. Stat. Rech. Gembloux. 3:96-106.
1055. Marchal, E. and R. Mayne. 1939. Etat Actuel de l'Etude de la Maladie
de l'Orme. Bull. Soc. Belg. XVI:193-202.
1056. Marchal, E. and G. Verplanke. 1926. (Champignons) Parasites Nouveaux pour la
Flore Bolge Observees de 1919 a 1925. (parasitic Fungi New to the
Belgian Flora Observed from 1919 to 1925). Bull. Soc. Roy. Bot.
Belgique 59:19-25, See pp. 24-25.

1057. Marchal, P. 1933. Les Aphides de l'Orme et Leurs Migrations. (Elm Aphids and Their Migrations). Ann. Epiph. 19:207-329.
1058. Marchal, P. and E. Foex. 1925. Rapport Phytopathologique pour l'Annee 1925. (Phytopathological Report for the Year 1925). Ann. Epiph. 11:412-470.
1059. Marchal, P. and E. Foex. 1927. Rapport Phytopathologique pour les Annees 1926-27. (Phytopathological Report for the years 1926-1927). Ann. Epiph. 13:383-454.
1060. Marchal, P. and E. Foex. 1928. Rapport Phytopathologique pour l'Annee 1928. (Phytopathological Report for the year 1928). Ann. Epiph. 14:415-70.
1061. Marchal, P. and E. Foex. 1929. Rapport Phytopathologique pour l'Annee 1929. (Phytopathological Report for the Year 1929). Ann. Epiph. 15:317-73.
1062. Marchal, P. and E. Foex. 1931. Rapport Phytopathologique pour l'Annee 1930. (Phytopathological Report for the Year 1930). Ann. Epiph. 17:1-61.
1063. Marchal, P. and E. Foex. 1932. Rapport Phytopathologique pour l'Annee 1931. (Phytopathological Report for the Year 1931). Ann. Epiph. 18:1-53, see p. 53.
1064. Marinos, M. G. 1967. Dutch Elm Disease in Minnesota. Minnesota Dept. Agric. Forest Pest Newsletter 7.
1065. Marinos, M. G. and D. W. French. 1971. Dutch Elm Disease in Minnesota, 1970. Plant Disease Reporter 55(8):682-683.
1066. Marsden, D. H. 1952. Pruning Elms Affected With Dutch Elm Disease. Abstr. in Phytopath. 42:113-114.
1067. Marsden, D. H. 1953. Dutch Elm Disease; an Evaluation of Practical Efforts. Plant Disease Reporter 37(1):3-6.
1068. Marshall, R. P. and A. M. Waterman. 1948. Common Diseases of Important Shade Trees. U.S.D.A. Farmer's Bull. #1987, 53 pp.
1069. Martin, C. H. 1936. Preliminary Report of Trap-log Studies on Elm Bark Beetles. Jour. Econ. Ent. 29:297-306.
1070. Martin, C. H. 1938. Field Notes on the life History of *Hylurgopinus rufipes* (Eich.) Jour. Econ. Ent. 31:470-477.

1071. Martin, J. P., Jr. and W. F. Jeffers. 1952. Screening Organisms for Antagonism to *Ceratostomella fimbriata*. Abstr. in Phytopath. 42:342.
1072. Martinez, J. B. 1936. La Grafiosis del Olmo y la Demonstracion de su Existencia en Espana. (Graphiosis of the Elm and the Demonstration of its Existence in Spain.) Inst. For. Inv. y Exp. Madrid 9(no. 15) 29 pp.
1073. Martinez, J. B. 1946. El Estado Actual del Problemo de la Grafiosis del Olmo. Montes, Madr. 1(2):48-56.
1074. Massachusetts Forest and Park Assoc. 1934. The Dutch Elm Disease. A Serious Menace to our American Elms. Bulletin (un-numbered). 154 pp., Illustrated.
1075. Massey, Calvin L. 1960. A New Species of Nematoda, *Cylindrocorpus erectus*, Associated With *Scolytus multistriatus* Marsh, in American Elm. Proceedings of the Helminthological Society of Washington. 27(1):42-43.
1076. Mathieson, A. 1950. Almsjukan Pattraffad i Sverige. Skogsagaren 26(4):72-75.
1077. Mathieson-Kaarik, A. 1953. Almsjukans Utbredning: Sverige Under Aren. 1950-52. Skogen. 40:2-3, 11.
1078. Matthysses, John G. 1958. An Evaluation of Mist Blowing and Sanitation in Dutch Elm Disease Control Programs. N.Y. Sta. Col. of Agr., Cornel Mis. Bull. 30, 16 pp.
1079. Matthysses, John G. et al. 1954. Insecticide Deposits for Control of Elm Bark Beetles. Jour. Econ. Ent. 47(5):739-746.
1080. Mattoon, H. G. 1963. Can Dutch Elm Disease be Controlled? Horticulture 41:274-275.
1081. May, C. 1930a. Dutch Elm Disease in Ohio. Science n.s. 72(1858):142-143.
1082. May, C. 1930b. The Dutch Elm Disease. 6th Nat. Shade Tree Conf. 6:91-94.
1083. May, C. 1931. The Dutch Elm Disease. In: Forty-ninth Annual Report. 1929-1930. Ohio Agr. Exp. Sta. Bull. 470:65-7, Illustrated.
1084. May, C. 1931. A New Elm Disease. Science (n.s.) 74:437.

1085. May, C. 1931. A New Elm Disease. Plant Disease Reporter 15:143-4
1086. May, C. 1931. Recent Study of the Dutch Elm Disease. Nat. Shade Tree Conf. 7:88-92.
1087. May, C. 1931. The Dutch Elm Disease. U.S.D.A. Circ. 170.
1088. May, C. 1932. Elm Disease Investigations. In: Fiftieth Annual Report, 1930-1931. Ohio Agr. Exp. Sta. Bull. 497:68-9.
1089. May, C. 1933. The Dutch Elm Disease. The Shade Tree 6:1-2.
1090. May, C. 1934. Outbreaks of the Dutch Elm Disease in the United States. U.S.D.A. Circ. 322. 19 pp.
1091. May, C. 1934. Notes on the Work of the Dutch Elm Disease Laboratory. Nat. Shade Tree Conf. 10:73-75.
1092. May, C. 1935. Dutch Elm Diseases. Plant Disease Reporter. Suppl. 90:99-100.
1093. May, C. 1935. The Dutch Elm Disease from the Research Standpoint. Proc. 11th Nat. Shade Tree Conf. 122-127.
1094. May, C. 1935. A Study of the Life History of *Ceratostomella ulmi* in Relation to the Development and Spread of the Dutch Elm Disease. Ph.D. Diss. Ohio State Univ.
1095. May, C. 1936. Dutch Elm Disease. Plant Disease Reporter Suppl. 96:257-258.
1096. May, C. 1936. The Dutch Elm Disease. Penn. Univ. Morris Arboretum Bull. 1(2):19-21.
1097. May, C. 1939. Inoculation and Infection of *Ulmus* by *Ceratostomella ulmi* in the U. S. P. 520. In Report of Proceedings Third Int. Cong. for Microbiology. New York. 1939. xi + 883 pp.
1098. May, C. 1940. Dutch Elm Disease. In Important Tree Pests of the NE. Edited by Committee on Forest Protection Leaflets. New England Section SAF. 147-150.
1099. May, C. 1940. Host-parasite relations of *Ceratostomella ulmi*. Proc. Third Int'l. Cong. for Microbiology. 1939:530-19.
1100. May, C. 1941. Methods of Tree Injection. Trees 4:7, 10-12, 14.

1101. May, C. 1945. Die-back of Elm. U.S. Bur. Plant Indus. Soils and Agr. Engin. 2 pp. (Processed). Revised 1951.
1102. May, C. 1947. Introduced Epidemic Shade and Forest Tree Diseases. Arborists News 12:25-31.
1103. May, C. 1953. The Dutch Elm Disease Problem. Nat. Shade Tree Conf. 29:60-69.
1104. May, C. and C. W. Collins. 1938. The Dutch Elm Disease in the United States and its Insect Vectors. West. Shade Tree Conf. Proc. (1938). 5:49-54.
1105. May, C. and W. R. Douglas. 1944. Some Factors Affecting the Value of Pruning for Dutch Elm Disease. Arborist's News 9:33-35.
1106. May, C. and G. F. Gravatt. 1931. The Dutch Elm Diseases. USDA Circ. 170. 10 pp.
1107. May, C. and G. F. Gravatt. 1937. Two Native Vascular Diseases of Eastern Hardwoods. U.S.D.A. Div. For. Path. Tree Pest Leaflet 19.
1108. May, C. and G. F. Gravatt. 1940. Two Native Vascular Diseases of Eastern Hardwoods. In: Important Tree Pests of the NE. Edited by Committee on Forest Protection Leaflets. New England Section. SAF. 151-154.
1109. May, C. and G. F. Gravatt. 1951. Vascular Diseases of Hardwoods. (Caused by *Verticillium albo-atrum* and *Dothiorella ulmi*). Tree Pest Leaf. Hillsboro, N.H. 19, 4 pp.
1110. May, C. and G. F. Gravatt. 1952. Two Native Vascular Diseases of Eastern Hardwoods. In: Important Tree Pests of the N.E. Edited by Committee on Tree Pest Leaflets. New England Section. SAF. Ed. 2, 118-121.
1111. May, C. and O. N. Liming. 1931. A Serious Elm Disease in Ohio. Ohio Agr. Exp. Sta. Bull. 150:106-112.
1112. May, C. and J. Zemlansky. 1941. Microagglutination of Spores of *Ceratostomella ulmi*. Abstr. in Phytopath. 31:15.
1113. May, C. et al. 1931. The Dutch Elm Disease in Ohio. Abstr. in Phytopath. 21:125.
1114. May, C. et al. 1958. Inhibition of Growth of *Ceratocystis ulmi* In Vitro by Residues From Extracts of Soils and of Plants Growing in Soils Treated With Captan or Orthocide 50 W. Plant Disease Reporter 42:696-702.

- 1115. May, C. et al. 1958. In Vitro Inhibition of *Ceratocystis ulmi* by Acetone Extracts From Leaves or Stem of Some Species of Higher Plants. Plant Disease Reporter 42(3):399-401.
- 1116. Mayhew, D. E. and A. H. Epstein. 1971. Elm Mosaic Virus in Iowa. Abstr. in Phytopathology 61(8):1024.
- 1117. McBride, Joe. 1973. Natural Replacement of Disease-killed Elms. The American Midland Nat. 90(2):300-306.
- 1118. McCallan, S. E. A. and F. R. Weedon. 1940. Toxicity of Amonia, Chlorine, Hydrogen Cyandie, Hyrorgen Sulphide, and Sulphur Gases. II Fungi and Bacteria. Contr. Boyce Thompson Inst. XI:325-330.
- 1119. McCallan, S. E. A. and R. H. Wellman. 1942. Fungicidal Verses Fungis-tatic. Contribution Boyce Thompson Inst. 12:451-464.
- 1120. McCallum, A. W. 1929. The European Elm Disease. Report of the Domi-nion Botanist for the Year 1928. Sect. 2:39-40.
- 1121. McCallum, A. W. 1933. Check List of Diseases of Forest and Shade Trees. Canada Dept. of Agr., Exp. Farms Branch. Ann. Rep. Canada Plant Disease Surv. 13:76-102.
- 1122. McCallum, A. W. 1934. The Dutch Elm Disease. Illus. Canad. Forest and Outdoors 30:741-742.
- 1123. McCallum, A. W. 1934. The Dutch Elm Disease. Can. Dept. of Agr. Pamphlet 159. 7 pp.
- 1124. McCallum, A. W. 1946. The Occurrence of Dutch Elm Disease in Canada. For. Chron. 22:203-209.
- 1125. McCallum, A. W. 1948. Dutch Elm Disease. For. Chron. 24:319.
- 1126. McCallum, A. W. and R. Macrae. 1947. Technique in the Diagnosis of Dutch Elm Disease. Bi-mon. Prog. Report For. Insect Invent. Canada Dept. of Agr. 3(6):4-6.
- 1127. McCallum, A. W. and K. E. Stewart. 1951. Dutch Elm Disease. Canada Dept. of Agriculture. Proc. No. 1, 10 pp.
- 1128. McCormick, Florence A. 1939. "*Cephalosporium* Die-back" of Elms. Phytopath. 29:371-372.
- 1129. McDaniel, E. L. 1935. A New Significance Concerning Insects Attacking Elm. Mich. Agr. Exp. Sta. The Quarterly Bulletin 17:142-144.

1130. McKenzie, M. A. 1936. Shade Tree Diseases. Conclustions From Studies of Several Thousand Specimens in the Laboratory of Massachusets State College. Amer. Nurseryman 64:7-8.
1131. McKenzie, M. A. 1937. The Dutch Elm Disease. A New Threat to the Elm. Bull. Mass. Agr. Exp. Sta. 343. 16 pp.
1132. McKenzie, M. A. 1937. Tree Diseases in Massachusetts. Plant Disease Reporter 21:55-59.
1133. McKenzie, M. A. 1945. Investigation of the Dutch Elm Disease in Massachusetts. Abstr. in Phytopath. 35:656.
1134. McKenzie, M. A. 1946. Dutch Elm Disease Studies in Massachusetts During 1945. Abstr. in Phytopath. 36:680.
1135. McKenzie, M. A. 1946b. Troublesome Tree Diseases in New England and Their Control. Nat. Shade Tree Conf. Proceedings 22:134-137.
1136. McKenzie, M. A. 1965. Natural Infection of Buisman Elm by *Ceratocystis ulmi*. Abstr. in Phytopath. 55:130.
1137. McKenzie, M. A. 1971. Progress Reports - Dutch Elm Disease. Mimeo. 3 pp. each (Jan. 1, June 1, Sept. 1):9 pp.
1138. McKenzie, M. A. 1972. Progress Reports - Dutch Elm Disease. Mimeo., 3 pp. each (Jan. 1, June 1, Sept. 1) 9 pp.
1139. McKenzie, M. A. and E. M. Johnson. 1939. *Cephalosporium* Elm Wilt in Massachusettes. Bull. Mass. Agric. Exp. Sta. #368.
1140. McLaine, L. S. 1934. The Relation of Entomology to the Dutch Elm Disease. Ontario Dept. Agr. Ent. Soc. Ontario Ann. Report 64(1933): 41-43.
1141. McLean, D. M. 1944. Histo-pathologic Changes in the Phloem of American Elm Affected With the Virus Causing Phloem Necrosis. Phytopath. 34:818-826.
1142. McNabb, H. S., Jr. 1964. A "New" Concept of Forest Tree Disease Control: Physiological Suppression. FAO/IUFRO Symposium on International Dangerous Forest Diseases and Insects Proc. 6 pp. Oxford, U.K.
1143. McNabb, Harold S., Jr. 1965. The European and His Trees. Proc. Midwestern Shade Tree Conf. 20:73-79.

1144. McNabb, H. S., Jr. 1971. A New Look at Dutch Elm Disease Control. The Amer. Forester 58:14-18.
1145. McNabb, H. S., Jr. 1974. Further Speculations on the Origin of Aggressive Strains of *Ceratocystis ulmi*. Abstracts of Papers Scheduled for Presentation at the 86th Session of the Iowa Academy of Science. Paper #12.
1146. McNabb, Harold S., Jr. and John H. Hart. 1962. Measurement of Xylary Fluid Movement in Elm by the Thermoelectric Method. Proc. Iowa Acad. Sci. 69:132-137.
1147. McNabb, H. S., Jr. et al. 1970. Anatomical Factors in Resistance to Dutch Elm Disease. Neth. J. Pl. Path. 76(3):196-204.
1148. McNabb, H. S., Jr. et al. 1974. Artificial Inoculation Techniques and Symptom Expression in Dutch Elm Disease. Abstracts of Papers Scheduled for Presentation at the 86th Session of the Iowa Academy of Science. Paper #15.
1149. McWain, Percy and G. F. Gregory. 1971. Solubilization of Benomyl for Xylem Injection in Vascular Wilt Disease Control. USDA Forest Service Research Paper NE-234.
1150. McWain, Percy and G. F. Gregory. 1972. A Benomyl Derived Fungitoxicant for Tree Wilt Disease Control. USDA For. Serv. Res. Note NE-162.
1151. Meer, J. H. Van der. 1926. *Verticillium*-wilt of Maple and Elm Seedlings in Holland. Phytopath. 16(9):611-614.
1152. Mehran, A. R. and R. Pomerleau. 1966a. Etude Autoradiographique de la Distribution du *Ceratocystis ulmi* dans les Jeunes Semis d'Orme. Nat. Canad. 93:351-353.
1153. Melching, John B. 1971. Markers Associated With Dutch Elm Disease Resistance in American Elms. Thesis (Sept., Cornell Univ.) Ex. Phytopath. News 4(12).
1154. Melching, J. B. and W. A. Sinclair. 1975. Hydraulic Conductivity of Stem Internodes Related to Resistance of American Elms to *Ceratocystis ulmi*. Phytopath. 65(5):643-644.
1155. Melhus, I. E. and G. C. Kent. 1939. Elements of Plant Pathology. MacMillan Company, New York. 1939.
1156. Melin, E. and J. A. Nannfeldt. 1934. Researches into the Bluing of Ground Wood-pulp. Sven. Shogsvaridsf. Tidshn. 32:347-616.

- 1157. Melville, R. 1944. The British Elm Flora. Nature Lond. 153:198-199.
- 1158. Merrill, W. 1967. Analyses of Some Epidemics of Forest Tree Diseases. Abstr. in Phytopath. 57:822.
- 1159. Merrill, W. 1968. Effect of Control Programs on Development of Epidemics of Dutch Elm Disease. Abstr. in Phytopath. 58:1060.
- 1160. Merrill, W. 1971. Elm Disease Control Programs Question of Aesthetics Vs. Cost. Science in Agri. XVIII:2.
- 1161. Metcalf, Haven. 1929. The Dutch Elm Disease. Nat. Shade Tree Conf. 5:60-61.
- 1162. Metcalf, Haven. 1930. Dutch Elm Disease Found in America. USFS Forest Worker 6(5):12-13.
- 1163. Metzger, R. 1927. Baume Werden Gegen Krankheiten Geimpff. Die Umschau 31:666.
- 1164. Meyer, H. J. and D. M. Norris. 1965. Dutch Elm Disease Today. Proceedings Nor. Cent. Branch Ent. Soc. America 1965:20.
- 1165. Meyer, H. J. and D. M. Norris. 1967. Behavioral Responses of *Scolytus multistriatus* (Marsh) to Host (*Ulmus*) and Beetle Associated Chemotactic Stimuli. Ann. Ent. Soc. Amer. 60:642-647.
- 1166. Meyer, H. J. and D. M. Norris. 1967. Vanillin and Syringaldehyde as Attractants for *Scolytus multistriatus*. Ann. Ent. Soc. Amer. 60(4):858-859.
- 1167. Meyer, M. P. and D. W. French. 1967. Detection of Diseased Trees. Photogrammetric Engineering 33:1035-1040.
- 1168. Middleton, William. 1934. Engraver Bark Beetles Attacking Elm Trees and Associated With the Dutch Elm Disease. Mim. Pub. Bur. Ent. U.S. Dept. Agr.:1-4.
- 1169. Miller, H. C. et al. 1969. Dutch Elm Disease: Relation of Spread and Intensification to Control by Sanitation in Syracuse, N.Y. Plant Disease Reporter 53:551-555.
- 1170. Miller, P. R. et al. 1933. Dutch Elm Disease (*Graphium ulmi*). Plant Disease Reporter Suppl. 84:45.
- 1171. Minn. Dept. Agr. Div. Plant Industry. 1963. Consolidated Insect Survey Report, Minnesota - 1962-1963.

1172. Misson, R. 1962. Should the Elm be Rescued From Decadence in Belgium? Bull. Soc. For. Belg. 69(3):129-149.
1173. Mitchell, A. F. 1973. Replacement of Elm in the Countryside. Leaf. For. Comm. 57, H.M.S.O.
1174. Mook, P. V. and D. O. Wolfenbarger. 1943. Distribution of *Beauvaria bassiana* on Elm Insects in the U.S. Phytopath. 33:76-77.
1175. Morrow, R. A. 1974. Dutch Elm Disease: Fungicidal Studies. Masters Thesis, Colorado State University.
1176. Moser, J. C. and L. M. Roton. 1972. Reproductive Compatibility Between Two Widely Separated Populations of *Pyemotes scolyti*. The Pan-Pacific Ent. 48:97-99.
1177. Moses, C. S. and C. H. Hoffman. 1940. Isolation of *Ceratocystis ulmi* From *Scolytus multistriatus* Adults Stored at Different Temperatures. Phytopath. 30:701:702.
1178. Mumenthaler, E. 1944. Das Ulmensterben in Bern. (The Dying-off of Elms in Berne.) Schweiz. Z. Forstw. XCV:50-52.
1179. Mumenthaler, E. 1947. Das Ulmensterben in Bern. (Elm Mortality in Berne.) Schweiz. Z. Forstw. XCVIII:239-242.
1180. Munro, J. W. 1926. British Bark Beetles. For. Comm. Bull. 8, 77 pp.
1181. Murdoch, C. W. et al. 1974. Survival of Conidia of *Ceratocystis ulmi* (Buisman) C. Moreau in Chain Saw Oil. Abstr. Pro. Am. Phytopath Soc. 1:141.
1182. Murtha, P. A. 1970. Thermal Image of Dutch Elm Disease. Bi-mon. Res. Notes 26(3):28-29.
1183. Myczkowski, S. 1954. Contributions to the Dutch Elm Disease. Acta Soc. Bot. Poloniae 23(3):635-636.
1184. Nash, R. W. et al. 1957. Elms Killed by Dutch Elm Disease Spoil Village Beauty. Maine For. Serv. Bull. #16.
1185. Neely, Dan. 1962. Control of Dutch Elm Disease in Illinois Municipalities. Proc. Ill. Tech. For. Assoc. 5(2):10-11.
1186. Neely, Dan. 1962. Dutch Elm Disease Control in Illinois. Midwest Institute of Park Executives. Proc. 21st Ann. Educational Conf. p. 24-27.

1187. Neely, Dan. 1963. Results of Dutch Elm Disease Control Efforts in Illinois. Proc. Midwestern Shade Tree Conf. 18:44-48.
1188. Neely, Dan. 1964. The Current Status of Dutch Elm Disease in Illinois. Illinois Natural History Surv. Mimeo. 4 p.
1189. Neely, Dan. 1965. Community Dutch Elm Disease Control in Illinois (1964). Illinois Natural History Survey Mimeo. 2 p.
1190. Neely, Dan. 1966. Municipal Dutch Elm Disease Control in Illinois. Illinois Natural History Survey Mimeo. 3 p. Feb.
1191. Neeley, D. 1967. Dutch Elm Disease in Illinois Cities. Plant Disease Reporter 51:511-514.
1192. Neely, Dan. 1967. Dutch Elm Disease Research in Illinois. Proc. Dutch Elm Disease Conf. June 29-30, 1967. USDA Research Lab. Delaware, Ohio. p. 9-14.
1193. Neely, D. 1968. Twig Inoculations on American Elm With *Ceratocystis ulmi*. Phytopath. 58:1566-1570.
1194. Neely, D. 1970. Dutch Elm Disease Symptom Progression. Plant Disease Reporter 54:127-129.
1195. Neely, Dan. 1972. Municipal Control of Dutch Elm Disease in Illinois Cities. Plant Disease Reporter 56(5):460-462.
1196. Neely, Dan. 1972. Progression of Internal and External Dutch Elm Disease Symptoms. Plant Disease Reporter 56(8):667-670.
1197. Neely, Dan. 1974. Efficacy of Soil Injections and Foliar Sprays of Benomyl for the Control of Dutch Elm Disease in Large Nursery Elms. Plant Disease Reporter 58(3):261-264.
1198. Neely, Dan. 1975. Sanitation and Dutch Elm Disease Control. In Dutch Elm Disease, Proc. I.U.F.R.O. Conference Sep. pp. 768. Minneapolis-St. Paul, Minn.
1199. Neely, Dan. 1975. Treatment of Foliar Diseases of Woody Ornamentals With Soil Injections of Benomyl. Plant Disease Reporter 59(4): 300-302.
1200. Neely, Dan and J. C. Carter. 1965. Species of Elm on the University of Illinois Campus Resistant to Dutch Elm Disease. Plant Disease Reporter 49:552.

1201. Neely, Dan and E. B. Himelick. 1962. Dutch Elm Disease and Oak Wilt "Cures". Arborist's News 27(1):1-3.
1202. Neely, Dan and E. B. Himelick. 1963. Root Graft Transmission of Dutch Elm Disease in Municipalities. Plant Disease Reporter. 47:83-85.
1203. Neely, Dan and E. B. Himelick. 1963. Supplemental Dutch Elm Disease Control Practices. Park Maintenance 16(4):58-61.
1204. Neely, Dan and E. B. Himelick. 1965. Effectiveness of Vapam in Preventing Root Graft Transmission of the Dutch Elm Disease Fungus. Plant Disease Reporter 49:106-108.
1205. Neely, D. and E. B. Himelick. 1966a. Effects of SMDC on Elm Roots. Plant Disease Reporter 50:473-476.
1206. Neely, D. and E. B. Himelick. 1966b. Simultaneous Determination of Fungistatic and Fungicidal Properties of Chemicals. Phytopath. 56:203-209.
1207. Neely, Dan. et al. 1960. The Status of Dutch Elm Disease in Illinois. Plant Disease Reporter 44:163-166.
1208. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1930. The Dutch Elm Disease. Nurs. Dis. Notes 3:4 pp. (Mimeo).
1209. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1933. The Dutch Elm Disease. Nurs. Dis. Notes 6:4 pp. (Mimeo).
1210. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1933. The Present Status of the Dutch Elm Disease in N.J. Nurs. Dis. Notes 6:13-16. (Mimeo).
1211. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1934. The *Cephalosporium* Wilt and Die-back of Elm. Nurs. Dis. Notes 7:23-28. (Mimeo).
1212. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1934. The Dutch Elm Disease. Circ. 296:2 pp.
1213. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1934. Elm Disease Circ. 308:2 pp.
1214. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1934. Elm Disease Reported From Indianapolis. Nurs. Dis. Notes 7:14. (Mimeo).
1215. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1934. The Elm Situation This Fall. Nurs. Dis. Notes 7:10-13.
1216. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1934. The Status of The Dutch Elm Disease. Nurs. Dis. Notes 6:41-44, 45-47. (Mimeo).

1217. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1935. Dutch Elm Disease - Why Eradication? Nurs. Dis. Notes 7:39-43. (Mimeo).
1218. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1935. Progress of Dutch Elm Disease eradication. Nurs. Dis. Notes 8:14-18. (Mimeo).
1219. New Jersey Agr. Exp. Sta., Dept. of Plant Path. 1936. Status of the Dutch Elm Disease. Nurs. Dis. Notes 9:5-10. (Mimeo).
1220. Nichle, W. R. 1964. Biological Control. In Review of the Dutch Elm Disease. Can. Dept. For. Bi-mon. Progress Report 20(4).
1221. Nielsen, G. R. 1959. New Additive to Old Insecticide Improves Control of Dutch Elm Disease. Farm. Res. Quart. Bull., N.Y. State Agr. Exp. Sta. 25(3):15.
1222. Noell. 1935. Nochmals Ulmenkrankheit. Blumenu. Pflbanz Ver, Gartenwelt. 39 (48):590-591.
1223. Norris, D. M. 1960. Systemic Insecticidal Action in the Cortical Tissues of Elm Twigs. Jour. Econ. Ent. 53:1034-1036.
1224. Norris, D. M. 1961. Insecticides for Dutch Elm Disease. American City 76(5):115-116.
1225. Norris, D. M. 1964. A Molecular Structure Requirement for a Systemic Insecticide to be Effective Against Elm Bark Beetles in Elm Twigs. Univ. Wisc. Forestry Notes. #16.
1226. Norris, D. M. 1967. Systemic Insecticides in Trees. Ann. Rev. Ent. 12:127-148.
1227. Norris, D. M. 1969. Transduction Mechanism in Olfaction and Gustation. Nature 222:1263.
1228. Norris, D. M. 1970. Quinol Stimulation and Quinone Deterrency of Gustation by *Scolytus multistriatus* (Coleoptera: Scolytidae). Ann. Ent. Soc. America 63:476-478.
1229. Norris, D. M. and J. E. Baker. 1967. Feeding Responses of the Beetle *Scolytus* to Chemical Stimuli in the Bark of *Ulmus*. Jour. Insect Physiol. 13:955-962.
1230. Norris, D. M. et al. 1970. An Energy-transduction Mechanism in Chemoreception by Bark Beetle, *Scolytus multistriatus*. Contribution Boyce Thompson Inst. 24:263-274.

1231. Northeastern For. Exp. Sta. 1961. No Title. Station Paper #156.
1232. Oates, J. T. 1963. An Experiment With Elm Chips. Trees Mag. Ohio 23(3):14.
1233. Oldham, J. N. 1930. On the Infestation of Elm Bark Beetles (Scolytidae) by a Nematode, *Parasitylenchus scolyti*. N. Sp. Jour. Helminth. 8: 239-248.
1234. Oshima, N. et al. 1973. Dutch Elm Disease in Colorado and Current Progress in Its Control. Abstr. in Today's Research Tomorrow's Colorado 86th Annual Research Conference, Colorado State Univ. Exp. Sta. Publication.
1235. Osmun, A. V. and M. A. McKenzie. 1936. Shade Tree Disease Survey of Massachusetts. Mass. Agr. Exp. Sta. Bull. 327 (Ann. Rep. 1935). 25-26.
1236. Otte, H. 1932. Die Wahre Ursache des Grossen Ulmensterbens. (The True Cause of the Great Elm Disease). Mollers Deut. Gart.-Ztg. 47:365-370.
1237. Otte, H. 1932. Nochmals: Das Ulmensterbens. Erwiderung auf die Angriffe des Herrn Kruepper. (Again: the Elm Disease. Answer to the Attack of Herrn Kruepper). Mollers Deut. Gart.-Ztg. 47:429-430.
1238. Otte, H. 1933. Die Ulmen-krankheit. Erwiderung auf die Beiden Angriffe in Nummer 18. (The Elm Disease. Answer to the Second Attack in Number 18). Mollers Deut. Gart.-Ztg. 48:251-252, 284-285.
1239. Ouellet, C. E. 1956. The Influence of X-ray and Thermal Neutron Irradiation of American Elm Seeds on the Germination and Early Growth of Seedlings. Conf. Brookhaven Natl. Lab. 215-218.
1240. Ouellet, C. E. 1962. Facteurs Pouvant Influencer la Multiplication de l'Orme d'Amérique (*U. americana* L.) par Boutures de Rameaux Feuillés. Can. Jour. Plant Sci. 42:150-162.
1241. Ouellet, C. E. and R. Pomerleau. 1965. Recherches sur la Resistance de l'Orme d'Amérique au *Ceratocystis ulmi*. Can. Jour. Bot. 43: 85-96.
1242. Ouellette, G. B. 1960. Studies of Host and Pathogen in Relation to the Infection Process of the Dutch Elm Disease, Caused by *Ceratocystis ulmi* (Buism.) C. Moreau. Ph.D. Thesis, Cornell Univ., Ithaca, N.Y. p. 123. 1960.

1243. Ouellette, G. B. 1961. Studies of Host and Pathogen in Relation to the Infection Process of the Dutch Elm Disease, Caused by *Ceratocystis ulmi* (Buis.) C. Moreau. Ph.D. Thesis Diss. Abstr. 21:3585.
1244. Ouellette, G. B. 1962a. Morphological Characteristics of *Ceratocystis ulmi* (Buis.) C. Moreau in American Elm Trees. Can. Jour. Bot. 40:1463-1466.
1245. Ouellette, G. B. 1962b. Studies on the Infection Process of *Ceratocystis ulmi* (Buis.) C. Moreau in American Elm Trees. Can. Jour. Bot. 40:1567-1575.
1246. Ouellette, G. B. 1963. Forest Disease Conditions. In Annual Report of the Forest Insect. and Disease Survey, 1962. Can. Dept. For., For. Ent. and Path. Branch. Ottawa. 1963.
1247. Ouelette, G. B. and C. Gagnon. 1960. Formation of Microendospores in *Ceratocystis ulmi* (Buisman) C. Moreau. Can. Jour. Bot. 38:235-241.
1248. Overdijkink, G. A. 1931. De Iepen ziekte. (The Dutch Elm Disease). Nederl. Boschboun-Tijdschr. 4(12):383-389.
1249. Overeem, D. M. and D. M. Elgersma. 1970. Accumulation of Mansonones E and F in *Ulmus hollandica* Infected With *Ceratocystis ulmi*. Phytochemistry 9:1949-1952.
1250. Ozolin, G. P. 1958. Seleksiya Ilemoveikh Porod na Ustoichivoste K Gollandskoi Bolezni. Uzbek Acad. Agr. Sci., Works of Central Asian Sci. Invest. Inst. Forestry, Tashkent, Bull. 4:1-89.
1251. Ozolin, G. P. 1959. (An Experiment in Selecting Elm Trees for Resistance to the Dutch Elm Disease). J. Agric. Sci. (Moscow) 4(12):139-142.
1252. Ozolin, P. 1959. Opeit Seleksiya Ilemoveikh Porod na Ustoichivoste k Gollandskoi Bolezni. Uzbek Acad. Agr. Sci., Works of Central Asian Sci. Invest. Inst. Forestry, Tashkent, Bull. 4:1-84.
1253. Pack, C. L. 1933. Another American Tragedy. Amer. Trees. Assoc. 1933:1-8.
1254. Pady, S. M. 1958. Dutch Elm Disease in Kansas. Plant Disease Reporter 42(3):402.
1255. Pafundi, M. A. 1974. Research Team Finds Dutch Elm Disease Control. Newsletter, Coll. Env. Sci. and For., State Univ. New York, Sep.
1256. Palmer, K. M. 1935. Dutch Elm Disease in Connecticut. Conn. Agr. Exp. Sta. Circ. 106:1-8.

1257. Pape, H. 1922. Krankheiten und Beschadigungen der Kulrutzpflanzen im Jahre 1920. (Diseases and Pests of Cultivated Plants in the Year 1920). Mitt. Biol. Reichsanst. Land und. Forstw. 23:110.
1258. Pape, H. 1924. Das Ulmensterben in Deutschland. (The Elm Disease in Germany). Mitt. Deut. Dendrol. Ges. 34:284-88, Illustrated.
1259. Pape, H. 1924. Ein Massenstorben von Ulmen in Deutschland. Nachr. Deutsch. Pflanz. 4:(11)84-85.
1260. Pape, H. 1924. Ueber das Ulmensterben. (On the Elm Disease). Garten-schonheit 8:165-166, Illustrated.
1261. Parisi, O. 1932. La Sostituzione del "*Celtis*" all "*Ulmus campestris*" e il Valore Alimentare della sua Foglia. (Substitution of *Celtis* for *U. campestris* and the Food Value of its Leaves). Ital. Agr. 69:49-51.
1262. Parker, K. G. et al. 1941. Transmission of the Dutch Elm Disease Pathogen by *Scolytus multistriatus* and the Development of Infection. Phytopath. 31:657-663.
1263. Parker, K. G. et al. 1947. Nutrition of the Trees and Development of Dutch Elm Disease. Phytopath. 37(4):215-224.
1264. Parker, K. G. et al. 1947. The Dutch Elm Disease: Association of *Ceratostomella ulmi* With *Scolytus multistriatus*, its Advance Into New Areas, Method of Determining its Distribution and Control of the Disease. Cornell U. Agr. Exp. Sta. 275. 44 pp.
1265. Parker, K. G. et al. 1948. The Association of *Hylurgopinus rufipes* With the Dutch Elm Disease Pathogen. Jour. Agr. Res. 76:175-183.
1266. Partridge, A. D. 1967. Dutch Elm Disease in Idaho. Univ. of Idaho, For. Wildlife and Range Exp. Sta. Note #9.
1267. Partridge, A. D. 1968. Dutch Elm Disease Found in Idaho. Plant Disease Reporter 52:46.
1268. Partridge, A. D. and D. L. Miller. 1972. Dutch Elm Disease Continues to Move East in the Idaho-Oregon Area. Plant Disease Reporter 56(11):939.
1269. Partridge, A. D. and H. N. Ward. 1969. Dutch Elm Disease in Idaho, 1968. Plant Disease Reporter 53:140-141.

1270. Partridge, A. D. and H. N. Ward. 1970. Dutch Elm Disease Spreads Slowly in Idaho. Plant Disease Reporter 54:701.
1271. Partridge, A. D. and H. N. Ward. 1971. Dutch Elm Disease Crosses Treeless Rangeland in Idaho. Plant Disease Reporter 55(12):1064.
1272. Partridge, A. D. and L. C. Weir. 1974. Dutch Elm Disease Moves to Oregon From Idaho. Plant Disease Reporter 58(1):75-76.
1273. Passavalli, L. P. 1932. La Diffusione in Italia di Olmi Resistenti al "*Graphium ulmi*". (The Spread of the *Graphium ulmi* Resistant Elm in Italy). Alpe. Riv. For. Ital. 19:38.
1274. Passavalli, L. P. 1932. Ancora Sugli Olmi Resistenti al "*Graphium ulmi*". (More on the Elms Resistant to "*Graphium ulmi*"). Riv. Alpe, For. Ital. 19:201.
1275. Passavalli, L. P. 1933. Recent Vedute sulla "Moria Degli Olmi" Dovuta al "*Graphium ulmi*". (Recent Views on the Elm Disease Due to *Graphium ulmi*). Alpe. Riv. For. Ital. 20:146-48.
1276. Passavalli, L. P. 1933. Cenni sui Pregi dell' "*Ulmus pumila*" in China. (Signs of the Value of *U. pumila* in China). Alpe Riv. For. Ital. 20:344-5.
1277. Passavalli, L. P. 1934. Il Primo Convengo Nazionale in Difesa dell' Olmo Campestre. (The First National Meeting in Defense of *U. campestris*). Alpe Riv. For. Ital. 21:158-159.
1278. Passavalli, L. P. 1935. L'Olmo Siberiana (*Ulmus pumila* L.) sua Importanza nella Difesa da *Ceratostomella* (*Graphium*) *ulmi* Buis. (The Siberian Elm ****, its Importance in the Control of ****). Alpe Riv. For. Ital. 22:409-418, Illus.
1279. Pavari, A. 1931. Nel Campo della Selvicoltura. (In the Field of Forestry). Alpe Riv. For. Ital. 18:510-515, Illustrated.
1280. Pawsey, R. G. 1972. Threat to the British Elm. Nature, Lond. 236 (5342):95.
1281. Pawsey, R. G. 1974. Dutch Elm Disease in 1973. Arboricultural Assoc. Jour. 2(6):179-188.
1282. Peace, T. R. 1932. The Dutch Elm Disease. Forestry 6(2);125-142.
1283. Peace, T. R. 1934. Report on the Dutch Elm Disease Survey of England. Typed Report. Sept. 1934.

- 1284. Peace, T. R. 1935. Report on the Elm Disease in Holland, Belgium and West Germany. Sept. 1935, Min. Report, Oct. 1935.
- 1285. Peace, T. R. 1936. Report on the Elm Disease in England, 1936. Min. Report Oct. 1936.
- 1286. Peace, T. R. 1938. Unpublished Report.
- 1287. Peace, T. R. 1939. The Resistance of Elms to the Disease Caused by *Ophistoma (Ceratostomealla) ulmi*. Imperial For. Inst., U. of Oxford Leaflet #2.
- 1288. Peace, T. R. 1947. Elm Disease - *Ceratostomella ulmi*. Forestry Comm. Leaflet #19, Revised.
- 1289. Peace, T. R. 1954. Experiments on Spraying With DDT to Prevent the Feeding of *Scolytus* Beetles on Elm and Consequent Infection With *Certostomella ulmi*. Ann. Appl. Biol. 41(1):155-164.
- 1290. Peace, T. R. 1960. The Status and Development of Elm Disease in Britain. Forestry Comm. Bulletin #33. 44 pp.
- 1291. Peace, T. R. 1960. The Status and Development of Elm Disease in Britain. Bull. For. Comm., Lond. 33:i-iv-1-44.
- 1292. Peacher, P. H. and C. A. Bower. 1969. Status of the Dutch Elm Diseases in Oklahoma. Plant Disease Reporter 53:768.
- 1293. Peacock, J. W. 1971. The Present Status of Research and Control of Dutch Elm Disease. Assoc. Phys. Plant Admin. East. Reg. Ann. Meeting. 20:28 pp. Illus.
- 1294. Peacock, J. W. 1973. Research on Chemical and Biological Control of Elm Bark Beetles. Proc. I.U.F.R.O. Conf. Sept. pp. 18-53.
- 1295. Peacock, J. W. et al. 1967. A Bioassay Technique for Elm Bark Beetle Feeding Stimulants. Ann. Entomol. Soc. Amer. 60:480-1.
- 1296. Peacock, J. W. et al. 1971. Attraction of *Scolytus multistriatus* (Coleptera: Scolytidae) to a Virgin-Female-Produced Pheromone in the field. Ann. Ent. Soc. Amer. 64(5):1143-1149.
- 1297. Peacock, John W. et al. 1971. Laboratory Investigations on the Frass of *Scolytus multistriatus* (Marsham) as a Source of Pheromone. North Central Branch, Ento. Soc. of America (Abstract).

1298. Peacock, J. W. et al. 1973. Laboratory Investigations of the Frass of *Scolytus multistriatus* (Coleoptera: Scolytidae) as a Source of Pheromone. Environ. Ent. 2:355-359.
1299. Peacock, J. W. et al. 1975. Collection on Porapak Q of the Aggregation Pheromone of *Scolytus multistriatus* (Coleoptera: Scolytidae). Jour. Chem. Ecol. 1(1):149-160.
1300. Pearce, G. T. et al. 1975. Chemical Attractants for the Smaller European Elm Bark Beetle *Scolytus multistriatus* (Coleoptera: Scolytidae). Jour. Chem. Ecol. 1(1):115-124.
1301. Pease, H. L. and R. F. Hart. 1971. Improved Method for Determining Benomyl Residues. Jour. Assoc. Off. Anal. Chem. 54:1399.
1302. Pechuman, L. L. 1938. A Preliminary Study of the Biology of *Scolytus sulcatus*, Le C. Jour. Econ. Ent. 31:537-543.
1303. Peterson, C. A. and L. V. Edgington. 1969. Quantitative Estimation of the Fungicide Benomyl Using a Bicautograph Technique. Jour. Agr. Food Chem. 17:898-899.
1304. Peterson, C. A. and L. V. Edgington. 1970. Penetration Through Bark by Benomyl. Proc. Can. Phytopath. Soc. p. 27.
1305. Peterson, G. W. 1963. Going, Going...Going...Gone. Courtesy of Dutch Elm Disease. Neb. Exp. Sta. Q. 9(4):10-11.
1306. Peterson, Glenn W. 1964. Dutch Elm Disease in Nebraska. Plant Disease Reporter 48(10):781.
1307. Peterson, Glenn W. and David S. Wysong. 1965. Dutch Elm Disease Distribution and Control in Nebraska. Nebr. Expt. Sta. Orrly. 11(4):15-16.
1308. Petrescu, M. et al. 1963. (Die-back of Elms in Romania). Stud. Cerc. Inst. Cerc. For. Bucuresti 23B:135-151.
1309. Petri, L. 1931. Provvedimenti Necessari per far Fronte alla Moria Degli Olmi. (Necessary Precautions to Take Against the Contagious Elm Disease). Bol. R. Staz. Patol. Veg. (Rome) n.s. 11:284-289.
1310. Petri, L. 1931. Rassegna dei casi Fitopathological Osservatinel 1930-1935. Bol. R. Staz. Patol. Veg. (Rome) n.s. 11:1-50 see p. 32; 12:1-64, see p. 43:13:1-73, see pp. 53-4; 14:1-78, see p. 49; 15:1-95, see p. 61; 16:1-25, see p. 17.

1311. Petri, L. 1932. Olme (*Ulmus sp.*). Boll. R. Staz. Path. Veg. n.s. 12: 43.
1312. Phillips, D. H. 1966. Forest Pathology Section. Report on Forest Research for the Year Ended March, 1963: March, 1964. 9:57-60.
1313. Pierce, A. S. 1934. Positive Infection Trials With Elm "Wilt" Fungi. Science 80:385.
1314. Plumb, G. H. 1950. Control of *Scolytus* and DED With Concentrated Sprays. Trees 10(5):8.
1315. Pisano, M. A. 1963. Activities of the *Cephalosporia*. Trans. N.Y. Acad. Sci. 25:716-730.
1316. Pitblado, R. E. and L. V. Edginton. 1972. Movement of Benomyl in Field Soils as Influenced by Acid Surfactants. Phytopathology 62(5):513.
1317. Poeteren, N. van. 1922. Verslag Over de Werkzaamheden van den Plantenzuktenkundigen Dienst in het Jaar 1920-21. (Report of the Activities of the Plant Disease Protection Service During 1920-1921). Verslag. en Meded. Plantenziektenk. Dienst Wageningen #27:92 pp.
1318. Poetren, N. van. 1923. Verslag 1922. (Report **** 1922). Verslag. en Meded. Plantenziektenk. Dienst Wageningen #31:59 pp.
1319. Poeteren, N. van. 1924. Verslag 1923. (Report **** 1923), Verslag. en Meded. Plantenziektenk. Dienst Wageningen #34:66 pp. see pp. 51-2, Illustrated.
1320. Poeteren, N. van. 1925. Verslag 1924. Versl. Med. Plantenz. Dienst Wageningen 41:48-50.
1321. Poeteren, N. 1926. Verslag 1925. (Report **** 1925). Verslag. en Meded. Plantenziektenk. Dienst Wageningen #44:124 pp., see pp. 80-1, Dec., 1926.
1322. Poeteren, N. van. 1928. Onderzoek Naar de Iepenziekte. Verslag. en Med. Plantenz. Dienst. Wageningen 51:7-8.
1323. Poeteren, N. van. 1928. Verslag 1926. (Report **** 1926) Verslag. en Meded. Plantenz. Dienst Wageningen #51:100 pp.
1324. Poeteren, N. 1929. Verslag 1928. (Report **** 1928). Verslag. en Meded. Plant Enziektenk. Dienst Wageningen #58:100 pp., see pp. 52-4, July, 1929.

1325. Poeteren, N. van. 1930. Verslag 1929. (Report **** 1929). Verslag. en Med. Plantenz. Dienst. Wageningen #62:144 pp.
1326. Poeteren, N. van. 1931. De Iepenziekte en Haar Bestrijding in 1930. Versl. Med. Plantenz. Dienst. Wageningen 64:106-117.
1327. Poeteren, N. van. 1932. De Iepenziekte en Haar Bestrijding in 1931. Versl. Med. Plantenz. Dienst. Wageningen 66:87-91.
1328. Poeteren, N. van. 1933. Comité Inzake Bestudeeringen Bestrijding van de Iepenziekte. Jaarverslag Over 1932. (Committee for the Study and Control of the Elm Disease. Annual Report for 1932). Tijdschr. Plantenz. 39:73-76.
1329. Poeteren, N. van. 1934. Verslag Over de Werkzaamheden van den Plantenziektenkundigen Dienst in het Jaar 1933. (Report of the Activities of the Plant Disease Protection Service During 1933). Verslag. en Meded. Plantenz. Dienst Wageningen #76:116 pp.
1330. Polak, O. 1932. Ohrozeni Nasich Jilmu Houbou *Graphium ulmi*. (Infection of our Elms With the Fungus, *Graphium ulmi*). Knihy Karna Petra Franka v Taboro 50:7 pp., Illustrated.
1331. Pollacci, G. 1932. Rassegna sull'Attività del Laboratorio Crittogamico di Pavia (Osservatorio Fitopatologico per le Provincie di Cremona, Parma, Pavia e Piacenza) Durante l'Anno 1931. (Report on the Activity of the Cryptogamic Laboratory of Pavia - Phytopathological Observatory for the Provinces of **** in 1931). Atti Inst. Bot. R. Univ. Pavia, Ser. IV. 3:311-324.
1332. Pollacci, G. 1933. Rassengna 1932. (Report 1932). Atti Inst. Bot. R. Univ. Pavia, Ser. IV. 4:283-301.
1333. Pollacci, G. 1934. Rassegna 1933. Report 1933). Atti. Inst. Bot. R. Univ. Pavia, Ser. IV. 5:275-95.
1334. Pomerleau, R. 1934. Notes sur la *Taphrina ulmi*. Naturaliste Canadien 1934: 305-308.
1335. Pomerleau, R. 1938. Recherches sur le *Gnomonia ulmea* (Schn.). Thum. Bidogre-ecologic Cytologie. Contrib. Inst. Bot. Univ. Montreal 31:1-130.
1336. Pomerleau, Rene. 1945. Distribution de la Maladie Hollandaise de l'Orme. Revue Canadienne Biologie 4(1):116-117.

1337. Pomerleau, Rene. 1945. L'Orme Manace de Disparaitre-la Maladie Hollandaise de l'Orme. Circulaire du Service Forestier, Ministere des Terres et Forets, Quebec.
1338. Pomerleau, Rene. 1945. The Problems of Forest Pathology in Quebec. Forestry Chronicle December, 1945.
1339. Pomerleau, Rene. 1946. Rapport General des Travaux Effectues sur la Maladie Hollandaise de l'Orme dans la Province de Quebec, 1945. Service Forestier, Ministere des Terres et Forests, Quebec.
1340. Pomerleau, Rene. 1947. Means of Inoculation of the Dutch Elm Disease by *Hylurgopinus rufipes* Eich. Can. Jour. Res. 25C:102-104.
1341. Pomerleau, Rene. 1947b. Organization of the Campaign Against Dutch Elm Disease in Quebec. Bi-mon. Prog. Rept. for Inst. Inves. Can. Dept. Agr. 3(6):1-2.
1342. Pomerleau, Rene. 1947. Rapport General des Travaux Effectues sur la Maladie Hollandaise de l'Orme dans la Province de Quebec, 1946. Service Forestier, Ministere des Terres et Forets, Quebec.
1343. Pomerleau, Rene. 1948. Dutch Elm Disease. For. Chron. 24:318.
1344. Pomerleau, Rene. 1948. Rapport General des Travaux Effectues sur la Maladie Hollandaise de l'Orme dans la Province de Quebec, 1947. Service Forestier, Ministere des Terres et Forets, Quebec.
1345. Pomerleau, Rene. 1949. Rapport General des Travaux Effectues sur la Maladie Hollandaise de l'Orme dans la Province de Quebec, 1948, Service Forestier, Ministere des Terres et Forets, Quebec.
1346. Pomerleau, R. 1949. Le Development de la Maladie Hollandaise de l'Orme. Suivant l'Epoque de l'Inoculation Annales de l'Acfas 15:109-111.
1347. Pomerleau, Rene. 1950. Rapport General des Travaux Effectues sur la Maladie Hollandaise de l'Orme dans la Province de Quebec, 1949. Service Forestier, Ministere des Terres and Forets, Quebec.
1348. Pomerleau, Rene. 1953. Dutch Elm Disease in the Province of Quebec. Bi-mon. Prog. Rep. 9(2):2.
1349. Pomerleau, Rene. 1961. History of the Dutch Elm Disease in the Province of Quebec. For. Chron. 37:356-367.
1350. Pomerleau, R. 1963. La Lutte Contre la Maladie d'Ormes dans le Quebec. Rep. Dep. Agr. Can., For. Ent. & Path. Branch 1963: 58-59.

1351. Pomerleau, Rene. 1964. Sanitation. (In a Review of the Dutch Elm Disease). Can. Dept. of For. Bi-mon. Prog. Rept. 20(4).
1352. Pomerleau, Rene. 1964. History of the Elm Disease in Canada. Can. Dept. For. Bi-mon. Prog. Rep.
1353. Pomerleau, Rene. 1965a. The Period of Susceptibility of *Ulmus americana* to *Ceratocystis ulmi* Under Conditions Prevailing in Quebec. Can. Jour. Bot. 43:787-792.
1354. Pomerleau, Rene. 1965b. Seasonal Transmission of the Elm Disease by *Hylurgopinus rufipes* in Quebec. Can. J. Bot. 43:1592-1595.
1355. Pomerleau, Rene. 1966. Relation of Early Cambial Activity in White Elm and Infection by *Ceratocystis ulmi* (Buis.) C. Moreau. Can. J. Bot. 44:109-111.
1356. Pomerleau, Rene. 1968. Progression et Localization de l'Infection par le *Ceratocystis ulmi* dans l'Orme d'Amerique. Phytopath. Zeitsch. 63:301-327.
1357. Pomerleau, Rene. 1970. Pathological Anatomy of the Dutch Elm Disease. Distribution and Development of *Ceratocystis ulmi* in Elm Tissues. Can. Journal of Botany 48(11):2043-2058.
1358. Pomerleau, Rene. 1970. Perspectives de Lutte Contre la Maladie Hollandaise de l'Orme. Phytoprotection 51:63-71.
1359. Pomerleau, Rene and J. Bard. 1968. Hardiness and Resistance to *Ceratocystis ulmi* (Buis.) C. Moreau, of Hybrids and Clones of European and American Elm. Bi-mon. Res. Notes. Can. Dept. of For. and R.D. 24:26.
1360. Pomerleau, Rene and J. Bard. 1969. Essai de Lutte Contre la Maladie Hollandaise de l'Orme au Quebec. Phytoprotection 50:38-45.
1361. Pomerleau, Rene and H. Lechevalier. 1947. Etude de l'Effect Antibiotique d'une Bacterie sur le Developpement du *Ceratostomella ulmi* (Schwarz) Buisman, Rev. Canadienne de Biol. 6:478-484.
1362. Pomerleau, Rene and A. R. Mehran. 1966. Distribution of Spores of *Ceratocystis ulmi* Labelled With Phosphorus 32 in Green Shoots and Leaves of *Ulmus americana*. Nat. Canad. 93:577-582.
1363. Pomerleau, Rene and R. Pelletier. 1967. A New Technique to Determine the Presence of *Ceratocystis ulmi* (Buis.) C. Moreau, in Fresh Elm Leaves, Shoots and Wood. Naturaliste Can. 94:59-62.

1364. Pool, R.A.F. and P. W. Hiatt. 1976. Dutch Elm Disease in California. Plant Disease Reporter 60(2):166-168.
1365. Pope, S. 1943. Some Studies on the Dutch Elm Disease and the Causal Organism. Ph.D. Thesis, Cornell Univ.
1366. Popovich, L. 1974. Dutch Beetles and American Scientists. J. of Forestry 72:589.
1367. Popushoi, I. S. 1959. (Dissemination of the Dutch Disease on Plantations in Moldavia). Les. Khoz. 12(10):50.
1368. Popushoi, I. 1962. Dutch Elm Disease in Moldavia. Infeacts Zabbleraniya Kul'turn Rast; Shinta Kitshinev 1:26-54.
1369. Potter, H. S. 1956. The Use of Chemicals to Suppress Symptoms of Dutch Elm Disease in Two-year-old American Elm Trees Inoculated With *Ceratocystis ulmi* (Schwarz) Buisman. Diss. Abstr. 16(12):2292.
1370. Prasad, R. 1971. Some Factors Affecting Foliar Absorption and Translocation of Benzimidazole Fungicides in Elm Seedlings. Unpublished Report to USDA Lab., Delaware, Ohio, April 1971. 2 pp.
1371. Prasad, R. 1972. Effect of pH on Uptake, Distribution and Accumulation of Benomyl by Elm Cuttings. Internal Report, Department of the Environment, Host Parasite Relationship, Presented to the Tree Physiology Workshop, Ottawa, Feb. 18-20. 10 pp.
1372. Prasad, R. 1972. Some Aspects of Foliar Penetration and Translocation of Benomyl in Elm Seedlings. Proc. II North American Forest Biology Workshop, Oregon, p. 15.
1373. Prasad, R. 1972. Translocation of Benomyl in Elm 1. Effects of Hydrogen in Concentration (pH) on Absorption, Distribution and Accumulation by Roots. Chem. Control Res. Inst. Can. For. Service Info. Rep. CC X-32.
1374. Prell, H. 1930. Ulmensterben und Ulmenborkenkafer. Manatsblatt Sachs Pflanz. Dresden 1930:1-9.
1375. Prell, H. 1930. Ulmensterben und Ulmeborkenkater Ursaehen and Bekampfung Einer Epidemischen Bankrankhet. Kranke Pflanzc. 7:89-93, 103-105, 124-127.
1376. Prell, H. 1931. Bekampfung des Ulmensterben. Reprint: Ministerial-blarr Gachsische Verwaltung:15.

1377. Quairiere, C. J. 1923. Note Sur le Deperissement des Ormes. (Note on the Dying of Elms). Bull. Soc. Centr. For. Belgique 26 (Ann. 30): 555-559.
1378. Radde-Fomin, O. G. 1936. Do Patannia pro Usikhannia il'ma. (The Question of the Elm Disease). Zhurn. Inst. Bot. VUAN (Jour. Inst. Bot. Acad. Sci. Ukraine). Ann. VI, Nov. 7(15):61-63. Ukrainian and Russian With German Summary.
1379. Radulescu, T. 1937. Beitrage zur Kenntniss der Baumkrankheiten. 2. Versuche uber das Ulmensterben. Forstwiss. Cbl. 79:629-643.
1380. Randall, H. et al. 1968. Dutch Elm Disease Found in South Dakota. Plant Disease Reporter 52:349.
1381. Rankin, W. H. 1933. Outbreak of the Dutch Elm Disease. Gard. Chron. Amer. 37:343-344.
1382. Rankin, W. H. 1935. Dutch Elm Disease - New York State. Nat. Shade Tree Conf. 11:138-142.
1383. Rankin, W. H. 1935. To Owners of Elm Trees in the Area Within 40 Miles of New York City. America's Trees: 3, March, 1935.
1384. Rankin, W. H. 1937. Summary of the Dutch Elm Disease Eradication Project. Proc. Nat'l. (U.S.) Shade Tree Conf. 1936, pp. 14-21.
1385. Rankin, W. H. et al. 1941. Dutch Elm Disease Prevalent in Bark Beetle Infested Elm Wood. Abstract in Phytopath. 31:19.
1386. Rankin, W. H. et al. 1941. Dutch Elm Disease Prevalent in Bark Beetle Infested Elm Wood. Jour. Econ. Ent. 34:548-551.
1387. Rauscher, K. J. et al. 1974. Response of Elm Species and Clone to Inoculation with *Verticillium albo-atrum*. Phytopath. 64:702-705.
1388. Readio, P. A. 1935. The Entomological Phases of the Dutch Elm Disease. Jour. Econ. Ent. 28:341-353.
1389. Readio, P. A. et al. 1937. The Dutch Elm Disease. N.Y. (Cornell) Agr. Exp. Sta. Ann. Rept. (1936) 49:100-101.
1390. Rebel, H. 1969. Phytotoxins of *Ceratocystis ulmi*: Isolation and Structure Investigation. Thesis, State Univ. of Utrecht.
1391. Rebel, H. and C. A. Salemink. 1969. The Isolation of Phytotoxins From Liquid Clutures of *Ceratocystis ulmi*. In 5th Int. Symp. Chromatogr. and Electrophoresis pp. 309-313.

1392. Reboul, A. and B. Taris. 1967. (Dutch Elm Disease: *Ceratocystis ulmi*)
Rev. For. Fr. 19:309-331.
1393. Reed, J. 1964. Methods of Control. Quarantine Regulations. In a
Review of the Dutch Elm Disease pp. 5-6, Can. Dept. For. Bi-mon.
Prog. Rept. 20(4):1-8.
1394. Reed, L. L. 1947. Surveys, Quarantine Regulations and Tree Removal
Policy. Bi-mon. Prog. Report For. Insect Invest. Can. Dept.
Agr. 3(6):4.
1395. Rehneit, F. 1934. Das Ulmensterben in Andermilichte. (The Elm
Disease in Another Light). Blumen u. Pflanzenb. Vereinght
Gartenw. 38:146.
1396. Reid, J. 1963. (Unpublished) Chemical Control of the Fungus and
Search for Pest Resistance. Mimeo Report - 1st Symposium on
Shade Trees Toronto.
1397. Reinboth, G. 1935. Das Burbanksterben in Italien (The Burbank Plum
Disease in Italy). Schweiz. Ztschr. Obst.-u. Weinbau 44:13-16.
1398. Reinboth, G. 1935. Die Burbank-katastrophe. (The Burbank Catastrophe).
Die Umschau 39:181-182.
1399. Reinboth, G. 1935. *Graphium ulmi* und die Burbank-pfalumen. Zeitschr.
Pflanzenker. 45:143-146. (Nachschrift by Tubeuf. p. 146).
1400. Renlund, D. W. 1969. Annual Report: Forest Pest Conditions in Wisconsin.
Wisc. Dept. of Nat. Res. 62 p.
1401. Rex, E. G. 1935. Local Situation Relative to Dutch Elm Disease.
National Shade Tree Conference 11:132-138.
1402. Rex, E. G. 1935. The Protection of New Jersey Elms. The Shade Tree
(N.J.) 8:(2).
1403. Rex, E. G. 1937. Is the American Elm Doomed? Flor. Exc. 88:17.
1404. Rex, E. G. 1941. Dutch Elm Disease Eradication in 1940. The Shade
Tree 14:2-8.
1405. Rex, E. G. 1945. Report on Dutch Elm Disease Control in New Jersey
for Calendar Year 1944. Shade Tree 18:3-4.
1406. Rex, E. G. 1949. A Dutch Elm Disease Control Program for New Jersey
for 1949. Bull. N.J. Shade Tree Comm. 22(1):1-4.

1407. Rex, E. G. and C. May, 1943. Natural Spread of Dutch Elm Disease in a small Area in New Jersey. *Arborist's News* 8:89-90.
1408. Rex, E. G. and J. H. Middleton. 1944. Recommended Disposition of Cut Elm Wood as an Aid in the Control of the Dutch Elm Disease in New Jersey. N.J. Dept. Agr. Cir. No. 346.
1409. Rexrode, C. O. 1974. Effect of Pressure - injected Oxydemeton-methyl, Cacodylic Acid and 2, 4-D amine on Elm Bark Beetle Populations in Elms Infected With Dutch Elm Disease. *Plant Disease Reporter* 58(4):382.
1410. Rexrode, C. O. and J. W. Lockyer. 1974. Laboratory Assay of Cacodylic Acid and Meta-systox-R on *Scolytus multistriatus* and *Pseudopityophthorus* sp. USFS Res. Note NE-190.
1411. Rey, E. 1930. Ulmensterben und Ulmensplitzkafer. (Elm Disease and Elm Bark Beetles). *Ent. Ztschr.* 44:262.
1412. Reynolds, H. A. 1934. The Dutch Elm Disease. *Mass. For. Park. Assoc. Bull.* 154:1-8.
1413. Reynolds, P. E. et al. 1972. Effect of Constant and Fluctuating Temperatures on In Vitro Growth of *Ceratocystis* Species. *Abstr. in Phytopathology* 62(5):499.
1414. Rhode, T. 1936. Beitrag zur Kenntnis Einer Krebsartigen Eichenkrankheit und ihrer Pilzflora. (A Contribution to the Knowledge of a Canker-like Oak Disease and its Fungus Flora). *Mitt. Forstw. U. Forstwiss* 7:63-116, see pp. 86-91 (*Ophiostoma* Key), Illustrated. *Bibl.*
1415. Richards, W. C. and S. Takai. 1973. Novel Technique for Isolating Microstructures Present in Shake Cultures of the Fungus *Ceratocystis ulmi*. *Appl. Micro.* 26(3):443-444.
1416. Richens, R. H. 1955. Studies on *Ulmus*: I. The Range of Variation of East Anglian Elms. *Watsonia* 3(3):138-153.
1417. Richens, R. H. 1967. Studies on *Ulmus*. VII Essex Elms. *Forestry* 40:185-206.
1418. Richter, H. 1931. Notizen zum Ulmensterben. (Notice on the Elm Disease). *Nachrichtenbl. Deut. Pflanzenschutz* 11:20.
1419. Richter, H. 1933. Das Ulmensterben. (The Elm Disease). *Mitt. Deut. Landw. Ges.* 48:676-677, Illustrated.

1420. Richter, H. 1934. Die Ausbreitung des Ulmensterbens in Nord-amerika (The Spread of the Elm Disease in North America). Nachrichtenbl. Deut. Pflanzenschutz 14:105-106.
1421. Richter, H. 1935. Absterben der Burbankpflaume in Italein wird Nicht Durch *Graphium ulmi* Verwsacht. (The Dying of Burbank Plum in Italy is not Caused by *Graphium ulmi*). Nachrichtenbl. Deut. Pflanzenschutz 14:41.
1422. Richter, H. 1935. Nochmals *Graphium ulmi* und die Burbankpflaume. (Again, *Graphium ulmi* and the Burbank Plum). Ztschr. Pflanzenkr. 45:302-303.
1423. Riedl, H. and J. W. Butcher. 1975. Aspects of Feeding Behavior of *Scolytus multistriatus* (Marsham) (Scolytidae: Coleoptera) and Implications for Control. Great Lakes Entomol. 8(3):139-144.
1424. Riedl, H. and J. W. Butcher. 1975. Rearing of *Scolytus multistriatus* (Marsham) (Scolytidae: Coleoptera) for Toxicological Experiments. Great Lakes Entomol. 8(3):135-137.
1425. Rishbeth, J. 1973. Slimeflux and Wetwood. Newsletter, the Assoc. of Tree Surgeons and Arborists, Aug. 1973, pp. 6-8.
1426. Robbins, W. J. and M. Roberto. 1942a. Vitamin Deficiencies of *Ceratostomella*. Bull. Torrey Bot. Club 69:184-203.
1427. Robbins, W. J. and M. Roberto. 1942b. Specificity of Pyridoxine for *Ceratostomella ulmi*. Bull. Torrey Bot. Club 69:322-352.
1428. Robbins, W. J. and M. Roberto. 1943. Pseudopyridoxine and Certain Fungi. Proc. Natl. Acad. Sci. U.S. 29:172-176.
1429. Robert, Fr. A. 1947a. Method and Time of Transmission of Dutch Elm Disease in Quebec. Can. Agri. Sci. Serv. For. Ent. Div. Bi-mon. Prog. Rept. 3(3):1.
1430. Robert, Fr. A. 1947b. The Biology of *Magdalis* and a New Aspect of its Role in the Transmissions of Dutch Elm Disease. Bi-mon Prog. Rept. For. Insect Investigation, Can. Dept. Agri. 3(5).
1431. Robert, Fr. A. 1947c. Research on Insects of Elm. Bi-mon. Prog. Rept. For. Insect Investigation, Can. Dept. Agri. 3(6):2.
1432. Robert, Fr. A. 1958. Insect Vectors of the Dutch Elm Disease in the Province of Quebec. Proc. Xth Intern. Cong. Ent. 1956. 4:433-436.
1433. Roberts, Bruce R. 1966. Transpiration of Elm Seedlings as Influenced by Inoculation With *Ceratocystis ulmi*. For. Sci. 12:44-47.

1434. Roberts, B. R. 1967. A Technique for Labelling *Ceratocystis ulmi* With Radiocarbon. Plant Disease Reporter 51:803-805.
1435. Roberts, B. R. 1968. An Evaluation of Three Methods for Measuring Leaf Water Potential in Dutch Elm Diseased Seedlings. Abstr. in Phytopath. 58:1064.
1436. Roberts, B. R. 1972. Net Photosynthesis, Growth, and Transpiration in American Elm Seedlings as Influenced by Dutch Elm Disease and Plant-water Stress. Phytopathology 62(4):457-460.
1437. Roberts, B. R. and K. R. Jensen. 1970. The Influence of Dutch Elm Disease and Plant-water Stress on the Foliar Nutrient Content of American and Siberian Elm. Phytopathology 60:1831-1833.
1438. Roberts, Bruce R. and Harold V. Main. 1965. The Effect of Chilling and Photoperiod on Bud Break in American Elm. J. Forestry 63:180-181.
1439. Roberts, B. R. and J. M. Stevens. 1968. Some Effects on Dutch Elm Disease on the Movement of ¹⁴C-Photosynthate in American Elm. Advanc. Front. Pl. Sci. New Delhi 21:127-134.
1440. Roberts, Bruce R. and R. Jay Stipes. 1967. The Effect of Captan and Cycloheximide on the Growth and Carbon Dioxide Exchange of *Ulmus americana*. Phytopathology 57:827.
1441. Roberts, B. R. and R. J. Stipes. 1969. Response of American Elm Seedlings to Treatment With Captan and Cycloheximide. For. Sci. 15:87-94.
1442. Roberts, B. R. et al. 1973. The Effect of Benomyl on the Growth of American Elm Seedlings. Phytopath. 63(1):85-88.
1443. Robinson, W. 1928. Determination of the Natural Undercooling and Freezing Points in Insects. Jour. Agr. Res., 37:749-755.
1444. Roepke, W. 1930. Die Bedeutung des *Scolytus scolytus* als Ubertrager der Sogenannten Hollandischen Ulmenkrankheit. (The Importance of *Scolytus scolytus* as a Vector of the So-called Dutch Elm Disease). Wanderversamml. Deut. Ent. 4:153-156.
1445. Roepke, W. 1930. Verdere Gegevens Omtrent de Iepenziekte en de Iepenspintkever. (Further Data Concerning the Elm Disease and the Elm Sap Beetle). Tijdschr. over Plantenz. 36(9):232-237.
1446. Roepke, W. 1933. Kort Verslag Over Het Iepenziekte-onderzoek Verricht op Het Laboratorium voor Entomologie te Wageningen, Gedurende Het Jarr 1932. (Short Report on the Elm Disease Research at the Entomology Laboratory at Wageningen During 1932. Tijdschr. Plantenz. 39:16-17.

1447. Roepke, W. K. J. 1934. Kort Verslag van het Iepen ziekte-onderzoek Verricht op het Laboratorium voor Entomologie te Wageningen Gedurende het Jaar 1933. Tijdschr. Plantenz. 40:91-93.
1448. Roepke, W. K. J. 1935. Kort Verslag Over het Iepen ziekte-onderzoek Verricht aan het Laboratorium voor Entomologie der Landbouwhoogeschool Gedurende het Jaar 1934. (Short Report on the Elm Disease Research of the Entomology Laboratory***During the Year 1934). Tijdschr. Plantenz. 41:121-124.
1449. Roepke, W. K. J. and J. Westerdijk. 1933. Iepen ziekte Onderzoek. (Report on the Elm Disease). Tijdschr. Plantenz. 39:16-20.
1450. Roll-Hansen. 1963. In Outbreaks and New Records. F A O Plant Protection Bulletin 11:69.
1451. Rosinski, M. A. 1961. Development of the Ascocarp of *Ceratocystis ulmi*. Amer. Jour. Bot. 48:285-293.
1452. Rosinski, M. A. 1965. Further Confirmation of the Occurrence of Cellulose in *Ceratocystis ulmi*. Mycologia 57:668.
1453. Rosinski, M. A. and R. J. Campana. 1965. Chemical Analysis of the Cell Wall of *Ceratocystis ulmi*. Mycologia 56:738-744.
1454. Roth, E. R. 1970. Dutch Elm Disease. In Resistance: A Literature Review of Important Insects and Diseases. USFS, Div. of For. Pest Control.
1455. Rovski, V. M. 1956. (Concerning a Radical Method of Controlling Dutch Elm Disease). (Bot. Zurn.). 41(10):1478-1481.
1456. Rudsen, P. L. 1965. Dutch Elm Disease (*Ceratocystis ulmi*) in Atlanta, Georgia. Plant Disease Reporter 48(4):288-291.
1457. Ruediger, E. 1929. Zur Ulmenkrankheit. (The Elm Disease). Ent. Ztschr. 43:50.
1458. Russo, G. 1938. Contributo alla Conoscenza die Coleotteri Scolitidi Fleotribo. *Phlocotribus scarabacoides* (Bern.). Fauv. Boll. Lab. Entomol. Agr. Portici 2:2-419.
1459. Rutgers, H. C. 1931. Bestrijding van Iepen ziekte en van Werkloosheid. (Fighting the Elm Disease and Unemployment). Nederl. Boschb.-Tijdschr. 4:394.

1460. Saleike, F. 1932. Ruckschnitt Kein Allheilmittel Gegen die Ulmenkrankheit. (Back-cutting, No Certain Remedy for the Elm Disease). Gartenwelt. 36:23.
1461. Salemink, C. A. et al. 1965. Phytotoxin Isolated From Liquid Cultures of *Ceratocystis ulmi*. Science 149:202-203.
1462. Sallmann. 1928. Das Grosse Ulmensterben. Radikaler Ruckschnitt das Einzige Abhifsmittel. (The Serious Elm Disease. Radical Back-cutting is the Only Remedial Measure). Gartenw. 32:49-50.
1463. Santamour, F. S., Jr. 1970. Natural Hybrids Between Chinese and Cedar Elms From Texas. Bull. Torrey Bot. Club 97:72-73.
1464. Santamour, F. S., Jr. 1972. Interspecific Hybridization With Fall and Spring-flowering Elms. For. Sci. 18:283-289.
1465. Santamour, F. S., Jr. 1973. Resistance to Dutch Elm Disease in Chinese Elm Hybrids. Plant Disease Reporter 57(12):997-1000.
1466. Santamour, F. S., Jr. 1974. Resistance of New Elm Hybrids to Dutch Elm Disease. Plant Disease Reporter 58(8):727-730.
1467. Santamour, F. S. and D. W. French. 1958. Toxin in Relation to Resistance to Dutch Elm Disease. Minn. For. Notes 65.
1468. Santi, A. 1934. La Moria Degli Olmi e i Sostegni delle Viti. (The Disease of the Elms, the Living Supports of the Vine). Riv. Agr. (Rome) 30:274.
1469. Saunders, J. L. and D. M. Norris. 1961. Nematode Parasites and Associates of the Smaller European Elm Bark Beetle, *Scolytus multistriatus*. Ann. Ent. Soc. Amer. 54:792-798.
1470. Savulescu, T. 1931. L'Etat Phytosanitaire en Roumanie Durant l'Annee 1929-1930. Ann. Inst. Rech. Agron. Roumanie 3:240-256.
1471. Savulescu, T. C. et al. 1934. L'Etat Phytosanitaire en Roumanie au Cours de l'Annee 1932-1933. (Phytosanitary Conditions in Rumania During the Year 1932-1933). Publ. Inst. Cerc. Agron. al Romanie 12:93 pp.
1472. Savulescu, T. et al. 1936. L'Etat Phytosanitaire en Roumanie en 1934-1935. (Phytosanitary Conditions in Rumania in 1934-1935). Publ. Inst. Cerc. Agron. al Romanie 25:97 pp.
1473. Scanlon, E. H. 1948. Elm Bark Beetle Conference. Trees 8(2):13, 16, 18, 23.

1474. Schenk, P. J. 1925. Die Iepenziekte. I-IX. (The Elm Disease). *Floralia* 44:8-9, 60-61, 137-9, 170-2, 186-7, 248-9, 659-60, Illustrated, 45:588-90 Illustrated; 46:371-7, Illustrated; Jan 12, Feb. 2, Mar. 9, 23, and 30, Apr. 27, Oct. 26.
1475. Schenkenberg van Mierop, H. W. 1930. De Vorming Von Thyllen Verband Met de Iepenziekte. (Formation of Tyloses in Connection With the Elm Disease). *Nederl. Boschb. Tijdschr.* 3:184.
1476. Schimitschek, E. 1927. Ulmensterven in Oesterreich. (Elm Disease in Austria). *Weiner Allg. Forst.-u. Jagd-Ztg.* 45(47):279-80.
1477. Schmidt, A. 1929. In Deutschland Sterben die Ulben. (In Germany the Elm are Dying). *Mollers Deut. Gart.-Ztg.* 44:298.
1478. Schneider, J. R. 1956. A Selective Medium for the Routine Isolation of *Graphium ulmi* Schwarz. *Plant Disease Reporter* 40:816-821.
1479. Schneider, J. R. 1957. Comparison of the Effects of Some Antibiotics, Antifungal Substances, and Phenyl Carbonates on the Growth of Two Vascular Parasites. *Plant Disease Reporter* 41(5):436-441.
1480. Schreiber, Lawrence R. 1963. Propagation of American Elm, *Ulmus americana* From Root Cuttings. *Plant Disease Reporter*. 47:1092-1093.
1481. Schreiber, L. R. 1966. Survival of *Ceratocystis ulmi* in American Elm Seedlings. *Abstr. in Phytopath.* 56:899.
1482. Schreiber, L. R. 1969. A Method for the Injection of Chemicals Into Trees. *Plant Disease Reporter*. 53:764-765.
1483. Schreiber, L. R. 1970. Viability of *Ceratocystis ulmi* in Young Seedlings of American Elm and the Effects of Extracts From Their Tissues on Conidial Germination. *Phytopathology* 60:31-35.
1484. Schreiber, L. R. 1970b. An Evaluation of Thiabendazole, 2-(4-thiazolyl) Benzimidazole, for the Control of Dutch Elm Disease. *Plant Disease Reporter* 54:240-241.
1485. Schreiber, L. R. and J. M. Harrison. 1962. Results of Three Treatments for the Control of Dutch Elm Disease (*Ceratocystis ulmi*). *Plant Disease Reporter* 46(6):401-403.
1486. Schreiber, L. R. and W. K. Hock. 1975. Effects of Benomyl and Thiabendazole on Growth of Several Plant Species. *Jour. Amer. Soc. Hort. Sci.* 100(3):309-313.

1487. Schreiber, L. R. and J. W. Peacock. 1974. Dutch Elm Disease and its Control. United States Forest Service and Ag. Res. Serv. Info. Bull. 193.
1488. Schreiber, L. R. and R. J. Stipes. 1966. A Method for the Inoculation of Elms With a Spore Suspension of *Ceratocystis ulmi*. Plant Disease Reporter 50:808-810.
1489. Schreiber, L. R. and R. J. Stipes. 1967. The Effects of Inoculum Spore Concentration on the Development of Foliar Symptoms of Dutch Elm Disease. Phytopath. 57:1269.
1490. Schreiber, L. R. and A. M. Townsend. 1974. Variability in Pathogenicity and Culture Characteristics of Geographically Diverse Isolates of *Ceratocystis ulmi* (A.B.S.). Phytopath. 64:885.
1491. Schreiber, L. R. and A. M. Townsend. 1976. Naturally Occurring Tolerance in Isolates of *Ceratocystis ulmi* to Methyl 2-benzimidazole-carbamate Hydrochloride. Phytopathology 66(2):225-227. Feb.
1492. Schreiber, L. R. and C. L. Wilson. 1969. Occurrence of Dutch Elm Disease in North Dakota. Plant Disease Reporter 53:994.
1493. Schreiber, L. R. et al. 1971. Influence of Planting Media and Soil Sterilization on the Uptake of Benomyl by American Elm Seedlings. Phytopathology 61(12):1512-1515.
1494. Schroeder, D. B. and D. W. French. 1961. Dutch Elm Disease Found in Minnesota. Plant Disease Reporter 45:749.
1495. Schuder, D. L. 1955. Distribution of Three Important Insect-transmitted Tree Diseases. Proc. Ind. Acad. Sci. 64:116-120.
1496. Schuster, J. E. and Dan Neely. 1970. Rate of Upward Movement of *Ceratocystis ulmi* in Elms. Plant Disease Reporter 54:58-59.
1497. Schwarz, H. 1933. Die Ursachen des Epidemischen Ulmensterbens und Die Moglichkeiten Seiner Bekampfung. (The Cause of the Epidemic and the Possibility of its Control). Gartenztg. Oesterr. Gartenb.-Ges (Vienna). 9:65-7.
1498. Schwarz, H. 1934. (The Die-back of Elms and its Agent). Oester Viertel. Fur Forstnesen 84:15-18.
1499. Schwarz, M. E. 1922. The Twig Wilt and the Vascular Disease of the Elm. Ulrecht. A. Oosthoeh. pp. 7-32.

1500. Schwarz, M. B. 1922. Das Zweigsterben der Ulmen, Trauerweiden und Pfirsichbäume. Thesis - Univ. Utrecht. 73 pp.
1501. Schwarz, M. B. 1922. Das Zweigsterben der Ulmen, Trauerweiden und Pfirsichbäume. (The Dying of Twigs of Elm, Weeping Willow and Peach.) Meded. Phyt. Labor Willie Comm. Scholt., Baarn. 5: 74 pp. Dec., 1922.
1502. Schwarz, M. B. 1922. Das Zweigdürre und die Gefässkrankheit der Ulmen. Med. Phyt. Lab. "Willie Comm. Scholten" Baarn 5:7-32. Dec., 1922.
1503. Schweitzer, D. L. and R. A. Skok. 1962. The Distribution and Commercial Importance of Elm Timber in Minnesota. Minn. For. Note No. 112. 2 pp.
1504. Schwerdtfeger, F. 1936. Die Wichtigeren Forstpathologischen Arberten des Jahres 1935. Kritische Übersicht. (The Outstanding Studies on Forest Pathology for the Year 1935. Critical Survey). Forstarchiv. Ztschr. Wissenschaftl. u. Techn. Fortschr. in Forstwirtschaft 12:142-8.
1505. Seale-Hayne Agr. College, Dept. of Botany. 1933. (No title). Pamphlet 40 (9 Ann. Rpt.):43 pp.
1506. Seale-Hayne Agr. College, Dept of Botany. 1934. Complete List of Diseases of Crops in Devon and Cornwall. Pamphlet 44 (11 Annual Report):43-49.
1507. Sekhon, H. S. 1974. In Vitro Effects of Herbicides on Fungal Pectolytic Enzymes. Abstr. In Proc. Amer. Phytopath Soc. 1:53.
1508. Sekhon, H. S. and G. H. Bridgman. 1972. Pairing fo Wyoming *Ceratocystis ulmi* Strains With Known Sexual Types. The Jour. of the Colorado Wyoming Academy of Science VII (2-3):105.
1509. Sekhon, H. S. and G. H. Bridgman. 1973. Determination of *Ceratocystis ulmi* Sexual Types Present in Wyoming. Plant Disease Reporter 57(7):576-578.
1510. Selle, G. Th. 1933. Das Ulmensterben. Fadenpilz *Graphium ulmi* und Ulmensplinkafer. (The Elm Disease. Hypholycteous *Graphium ulmi* and the Elm Bark Beetle). Mollers Deut. Gart.-Ztg. 48:323.
1511. Selli, S. 1933. Note e Condiderazioni sul *Graphium ulmi*. (Note in Consideration of *Graphium ulmi*). Romagna Agril Zootecn. 27:134.
1512. Selling, H. A. et al. 1970. Transformation of the Systemic Fungicide Methyl Thiophanate into 2-Benzimidazole Carbamic Acid Methyl Ester. Chem. Inc., Lond. 1625-1626.

1513. Shafer, T. and O. N. Liming. 1950 *Ceratostomella ulmi* Types in Relation to Development and Identification of Perithecia. *Phytopath.* 40: 1035-1042.
1514. Shigo, A. L. 1960. Parasitism of *Gonatobotryum fuscum* on Species of *Ceratocystis*. *Mycologia* 52:584-598.
1515. Shurtleff, M. C. 1972. The Latest On Dutch Elm Disease Control. *Grounds Maint.* Mar. (72):44-46, 48.
1516. Sibilila, C. 1930. (Die-back of Elms in Italy). *Boll. R. Staz. Pat. Veg.* n.s. 10:281-283.
1517. Sibilila, C. 1930. La Moria Degli Olmi Prodotta da *Graphium ulmi* Schwarz. *Boll. R. Staz. Path. Veg.* n.s. 10:311-325.
1518. Sibilila, C. 1931. Una Nuova Malattie Degli Olmi Segnalata in Italia. (A New Elm Disease Noted in Italy). *Aple Riv. for. Ital.* 18: 413-417, illustrated.
1519. Sibilila, C. 1932. La Resistenza dell *Ulmus pumila* al *Graphium ulmi*. *Boll. R. Staz. Path. Veg.* n.s. 12:360-364.
1520. Sibilila, C. 1933. Ulteriori Notizie sulle Resistenza dell *Ulmus pumila* a *Ceratostomella ulmi* Buis. *Boll. R. Staz. Path. Veg.* n.s. 13(4):561-565.
1521. Sibilila, C. 1935. Saggi sulla Resistenza di Alcuni a *Ceratostomella ulmi* Buis. *Boll. R. Staz. Path. Veg.* n.s. 15:116-121.
1522. Sibilila, C. 1940. L'*Ulmus Pumila* es la Arafiori Grafiosi. *Bull. Staz. Pat. Rey. Roma* 20(2):147-419.
1523. Siemaszko, W. 1935. (The Vascular Disease of the Elm by *Ceratostomella (Graphium) ulmi* (Schwarz) Buisman in Poland). *Roczn. Nauk Ogrod. Graphi und Buisman.* 2:163-172.
1524. Sinadskii, Y. V. 1960 (Dutch Disease, the Basic Factor in the Destruction of Elm in the Krasnogo Forest). *Trud. Kavkaz. gos. Zapoved.* 6:133-135.
1525. Sinclair, W. A. 1967. Effects of Three Carboxylic Acids on Young Elm Trees and on Dutch Elm Disease. *Plant Disease Reporter* 51:1077-1078.
1526. Sinclair, W. A. and W. D. Brener. 1974. Dutch Elm Disease in Clones From White Elms Resistant and Susceptible to *Ceratocystis ulmi*. *Phytopath.* 64(5):675-679.

1527. Sinclair, W. A. and J. A. Weidhaas, Jr. 1967. Dutch Elm Disease and its Control in New York State. Cornell Univ. Exten. Bull. 1185.
1528. Sinclair, W. A. et al. 1972. Anatomical Marker for Resistance to Dutch Elm Disease in *Ulmus americana*. Abstract in Phytopathology 62(7): 789.
1529. Sinclair, W. A. et al. 1973. Localization of Infection in American Elms Resistant to *Ceratocystis ulmi*. Phytopath. 63(2):207.
1530. Sinclair, W. A. et al. 1974. Selection of American Elms for Resistance to *Ceratocystis ulmi*. Plant Disease Reporter 58(9):784-788.
1531. Sinclair, W. A. et al. 1975. Anatomical Marker for Resistance of *Ulmus americana* to *Ceratocystis ulmi*. Phyta 65(3):349-353.
1532. Sinclair, W. A. et al. 1975. Localization of Infection in American Elms Resistant to *Ceratocystis ulmi*. Phyta 65(2):129-134.
1533. Singh, B. 1968. Pathogenesis in Dutch Elm Disease. Ph.D. Thesis Univ. of Wisconsin.
1534. Singh, D. and E. B. Smalley. 1964. Nitrogenous Compounds in the Xylem Sap of Elms With Dutch Elm Disease. Abstr. in Phytopath. 54:908.
1535. Singh, D. and E. B. Smalley. 1966. Nitrogenous Compounds in the Xylary Sap of Ulmaceae Species Varying in Resistance to Dutch Elm Disease. Abstr. in Phytopath. 56:901.
1536. Singh, D. and E. B. Smalley. 1967. Effects of Early and Late Inoculations of *Ulmus americana* With *Ceratocystis ulmi* on the Relative Concentrations of Nitrogenous Compounds in the Xylem Sap. Abstr. in Phytopath. 57:831.
1537. Singh, D. and E. B. Smalley. 1969. Changes in Amino Acid and Sugar Constituents of the Xylem Sap of American Elm Following Inoculations With *Ceratocystis ulmi*. Phytopath. 59:891-896.
1538. Singh, D. and E. B. Smalley. 1969. Nitrogenous and Carbohydrate Compounds in the Xylem Sap of Ulmaceae Species Varying in Resistance to Dutch Elm Disease. Can. Jour. Bot. 47:335-340.
1539. Singh, D. and E. B. Smalley. 1969. Nitrogenous Compounds in the Xylem Sap of American Elms With Dutch Elm Disease. Can. Jour. Bot. 47: 1061-1066.

1540. Singh, D. and E. B. Smalley. 1969. Nitrogenous Compounds in the Xylem Sap of *Ulmus americana*; Seasonal Variations in Relation to Dutch Elm Disease Susceptibility. For. Sci. 15:299-306.
1541. Skoric, J. 1943. Holandska Bolest Briestova. (Dutch Elm Disease). Hrv. Sum. L. 3:3-11.
1542. Slate, W. L. 1931. Elm Disease under Investigation. Can. Agr. Exp. Sta. Bull. 322(1930):119.
1543. Slinger, Lucille. 1974. Polygalacturonase Activity Produced by *Ceratocystis ulmi*. Grown in the Presence of Various Carbon Sources. Abstr. Proc. Am. Phytopath. Soc. 1:130.
1544. Sloane, R. A. 1965. Tree Program Restricts Elm Losses. American City 79(10):165-166.
1545. Smalley, E. B. 1962a. Factors Influencing Germ Tube Development in Conidia of *Ceratocystis ulmi*. Abstr. in Phytopath. 52:753.
1546. Smalley, E. B. 1962b. Prevention of Dutch Elm Disease by Treatments With 2,3,6-trichlorophenyl acetic Acid. Phytopath. 52:1090-91.
1547. Smalley, E. B. 1963. Seasonal Fluctuations in Susceptibility of Young Elm Seedlings to Dutch Elm Disease. Phytopath. 53:846-53.
1548. Smalley, E. B. 1965. Controlling Root Graft Transmission of Dutch Elm Disease. Proc. Midwestern Chapter Int. Shade Tree Conf. 20:41-46.
1549. Smalley, Eugene B. 1966. Prophylaxis against Dutch Elm Disease. United States Patent 3,257,271. Patented June 21, 1966. Assignor to Wisconsin Alumni Research Foundation, Madison, Wisconsin. A Corporation of Wisconsin.
1550. Smalley, Eugene B. 1967. Present Status of Dutch Elm Disease Research in Plant Pathology at Wisconsin. In: Proceedings, USDA Regional Conference on the Control of Dutch Elm Disease. June 29-30, 1967. Delaware, Ohio. pp. 16-20.
1551. Smalley, E. B. 1971. Prevention of Dutch Elm Disease in Large Nursery Elms by Soil Treatment With Benomyl. Phytopath. 61:1351-1354.
1552. Smalley, E. B. 1972. Benomyl for Practical Control of Dutch Elm Disease. Presented to: 8th Annual Meeting, Society of Municipal Arborists. Charter House Hotel, Buffalo, New York. October 6.

1553. Smalley, E. B. 1974. Dutch Elm Disease Cure. Proc. of G.C.S.A.A.'s 45th Internat. Conf. and Show. Anaheim, Calif. Feb. 10-15, 1974:48-49.
1554. Smalley, E. B. 1975. New Controls for Dutch Elm Disease. Proc. of the 1975 Reg. Park and Rec. Conf. Mid-Continent Assoc. Aug. 13, 1975. Milwaukee, Wis.
1555. Smalley, E. B. and A. G. Kais. 1966. Seasonal Variations in the Resistance of Various Elm Species to Dutch Elm Disease. In: Breeding Pest-resistant Trees, a Symposium. Pergamon Press.
1556. Smalley, E. B. and D. T. Lester. 1974. Elm. In McGraw-Hill Yearbook of Science and Technology. 1974:172-174.
1557. Smalley, E. B. and A. J. Riker. 1962. Reactions of Several Tropical Members of the Ulmaceae to Inoculation with *Ceratocystis ulmi*. Phytopath. 52:28.
1558. Smalley, E. B. and A. J. Riker. 1962. Tropical Members of the Ulmaceae Resistant to Dutch Elm Disease. Wisconsin Univ. For. Res. Notes, No. 99, 1-4.
1559. Smalley, E. B. and R. B. Stevens. 1967. Production of the Dutch Elm Disease in American Elm by *Ceratocystis ulmi*. p. 10-11. In: Arthur Kelman (Ed.), Sourcebook of Laboratory Exercises in Plant Pathology. W. H. Freeman, San Francisco.
1560. Smalley, E. B. et al. 1973. Benomyl for Practical Control of Dutch Elm Disease. Phytopathology 63(10):1239-1252.
1561. Smith, J. A. 1962. An Evaluation of Tree Saver as a Preventive or Cure for Dutch Elm Disease. Arbor. Leaves 4(2):10-11.
1562. Smucker, S. J. 1935. Air Currents as a Possible Carrier of *Ceratostomella ulmi*. Phytopath. 25(4):442-443.
1563. Smucker, S. J. 1937. Relation of Injuries to Infection of American Elm by *Ceratostomella ulmi*. Abstr. in Phytopath. 27(2):140.
1564. Smucker, S. J. 1938. Centrifugal Movement of *Ceratostomella* in Inoculated American Elms. Abstr. in Phytopath. 28(1):19.
1565. Smucker, S. J. 1940. Apparent Recovery of American Elms Inoculated With *Ceratocystis ulmi*. Phytopath. 30:1052-1054.
1566. Smucker, S. J. 1941a. Susceptibility of *Planera* and Several Elm Species to *Ceratostomella ulmi*. Abstr. in Phytopath. 31:21.

1567. Smucker, S. J. 1941b. Comparison of Susceptibility of the American Elm and Several Exotic Elms to *Ceratostomella ulmi*. *Phytopath.* 31: 758-759.
1568. Smucker, S. J. 1942. *Scolytus sulcatus* and Apple Trees in Relation to the Dutch Elm Disease Control Program. *Phytopath.* 32:441-443.
1569. Smucker, S. J. 1944. Rebuilding the American Elm. *American Forests* 50:104-107.
1570. Solaroli, V. 1933. Recerche Intorno al *Graphium ulmi*. (Research on *Graphium ulmi*.) *Romagna Agr. Zootecn.* 27:33-47.
1571. Solel, Z. and L. V. Edgington. 1973. Transcuticular Movement of Fungicides. *Phytopath.* 63:505-510.
1572. Spencer, J. F. T. and P. A. V. Gorin. 1971. Systematics of the Genera *Ceratocystis* and *Graphium*. Proton Magnetic Resonance Spectra of the Mannose-containing Polysaccharides as an Aid in Classification. *Mycologia* 63:387-403.
1573. Spierenburg, Dina. 1921. Een Onbekende Ziekte in de Iepen. *Plantenz. Waarnemingen* I:3-10.
1574. Spierenburg, D. 1921. Een Onbekende Ziekte in de Iepen. *Tijdschr. Plziekt.* 27(5):53-60.
1575. Spierenburg, Dina. 1922. Een Onbekende Ziekte in de Iepen II. *Plantenz. Waarnemingen* III:1-31.
1576. Spierenburg, Dina. 1923. New Elm-tree Disease. Rept. Intern. Conf. *Phytopath and Econ. Entom. Holland* 1923:123-234.
1577. Spierenburg, Dina. 1929. Eenige Oude Gegevens Over Ziekten in Boomen (Voornamelijk in Iepen). (Some old References to Tree Diseases - Especially in Elms). *Tijdschr. Plantenz.* 35:289-309.
1578. Spradbery, J. P. 1968. A Technique for Artificially Culturing Ichneumonid Parasites of Woodwasps (Hymenoptera: Siricidae.) *Entomol. Exp. Appl.* 11:257-260.
1579. Stapp, C. 1928. Bakteriosen der Ulmaceen. (Bacteria on the ulmaceae). In Soraver's *Handbuch der Pflanzenkrankheiten* 2(1):78-9, ed. 5.
1580. Stapp, C. 1928. (On the Cause of the Die-back of Elms). *Mitt. Deutsch. Dendrol. Ges.* 40:139-146.

1581. Stapp, C. 1931. Derzeitiger Stand der Erforschung des "Ulmensterbens". (Present Status of the Research Work on the Elm Disease). Mitt. Deut. Dendrol. Ges. 43:334-42.
1582. Stapp, C. 1933. Von "Ulmensterben". (On the Elm Disease). Mitt. Deut. Dendrol. Ges. 45:276-282.
1583. Stebbing, E. R. 1948. Elm Disease. Nature 162(4109):196-197.
1584. Stefanov, D. 1947. (The Wilting of Elms in Bulgaria and More Especially the Wilting of Elm Stands in the Longosa State Forest). Gorsko Stopanstro, Sofia 3:6-13.
1585. Steinhaus, E. A. 1954. The Effect of Disease on Insect Populations. Hilgardia. 23:197-261.
1586. Sterner, T. E. 1975. Evaluation of New Compounds in Arresting Growth of *Ceratocystis ulmi* in Elm Branch Sections. Plant Disease Reporter 59(8):638-640.
1587. Stevens, N. E. 1932. The Spread of Some Introduced Diseases of Trees. Intern. Bull. Plant. Prot. 6:3.
1588. Stevens, N. E. 1933. Known Distribution of Dutch Elm Disease in the United States. Plant Disease Reporter 17:133.
1589. Stevens, N. E. 1933. Spread and Severity of the Dutch Elm Disease in Europe. Plant Disease Reporter 17:117-118.
1590. Stevens, N. E. 1933. United States: The Dutch Elm Disease Discovered in New Jersey. Intern. Bull. of Plant Prot. 7(10):229-230.
1591. Stewart, K. E. 1947. Investigation on the Chemical Control of the Native Elm Bark Beetle *Hylurgopinus rufipes*. Bi-mon. Prog. Rept. For. Insect Invest. Can. Dept. Agri. 3(6):2-4.
1592. Stillwell, M. A. 1966. A Growth Inhibitor Produced by *Cryptosporiosis* sp., an Imperfect Fungus Isolated From Yellow Birch, *Betula alleghaniensis*. Britt. Can. Jour. Bot. 44:250-267.
1593. Stipes, R. J. 1964. Chemotherapeutic Patterns of Methyl - q - (Butyl-carbamoyl)-2- Benzimidazole - Carbamate and Thiabendazole in the Control of Dutch Elm Disease. Abstr. in Phytopath. 59:1560.
1594. Stipes, R. J. 1970. Comparative Mycelial Protein and Enzyme Patterns of Four Species in *Ceratocystis*. Mycologia 62:987-995.

1595. Stipes, R. J. 1973. Chemical Control of *Ceratocystis ulmi* - An Overview. Proc. I.U.F.R.O. Conf. Sept. pp. 1-18.
1596. Stipes, R. J. 1973. Control of Dutch Elm Disease in Artificially Inoculated American Elms With Soil-Injected Benomyl, Captan, and Thiabendazole. Phytopath. 63(6):735-739.
1597. Stipes, R. J. 1973. Dutch Elm Disease: Its Control With Soil-injected Fungicides. Virginia Plant Protection Newsletter 5:3.
1598. Stipes, R. J. and Donna R. Oderwald. 1971. Dutch Elm Disease: Control With Soil-injected fungicides and surfactants. Phytopath. News 5(7) Session 15, No. 159, APS Meeting, Philadelphia, Pennsylvania.
1599. Stipes, R. J. and Donna R. Oderwald. 1971. Dutch Elm Disease: Control With Soil-injected Fungicides and Surfactants. Phytopath. 61(8): 913 (Abstract).
1600. Stipes, R. J. and L. R. Schreiber. 1966. An Evaluation of Certain Chemicals With Dimethyl Sulfoxide and of X-D. E. A. in the Control of Dutch Elm Disease. Plant Disease Reporter 50:573-75.
1601. Stipes, R. J. and L. R. Schreiber. 1967. Recent Trials of Captan and Other Fungicidal Agents in the Control of Dutch Elm Disease. Plant Disease Reporter 51:533-536.
1602. Stipes, R. J. and J. A. Weidhaas, Jr. 1971. Dutch Elm Disease and its Control in Virginia. Plant Disease Control Notes, Control Series 103:6. Virginia Polytech. Inst.
1603. Stipes, R. J. and K. E. Weinke. 1972. Dutch Elm Disease: Control With Soil-amended Fungicides. Plant Disease Reporter 56(7):604-607.
1604. Stoddard, E. M. 1946. Soil Applications of Oxyquinoline Benzoate for the Control of Foliage Wilting in Elms Caused by *Graphium ulmi*. Abstr. in Phytopath. 36:682.
1605. Stoddard, E. M. 1949. The Chemotherapy of Plant Diseases. Bot. Rev. 15(6):345-376.
1606. Stoddard, E. M. and G. A. Zentmyer. 1943. Possible Chemical Similarity of Virus and Fungus Toxins. Abstr. in Phytopath. 33:20.
1607. Strong, F. C. 1932. The Dutch Elm Disease - a Warning. Mich. Agr. Exp. Sta. Quart. Bull. 15:6-8.
1608. Strong, F. C. 1938. Prevalence of Wilt Disease in Maple and Elm. Bull. Mich. Agri. Exp. Sta. 21(2):96-99.

1609. Sturgeon, R. V. 1972. Systems Control of Dutch Elm Disease. Ext. Note Okla. State Univ.
1610. Suffolk, Naturalists' Society. 1931. Report of the Society upon the Progress of the Dutch Elm Disease in Suffolk. Transactions 1: 219:220.
1611. Swingle, R. U. 1935. The Dutch Elm Disease. In: Fifty-third Ann. Report 1933-34 Ohio Agri. Exp. Sta. Bull. 548:37-38.
1612. Swingle, R. U. 1936. A Preliminary Note on Sexuality in *Ceratostomella ulmi*. Phytopath. 26:925-927.
1613. Swingle, R. U. 1938. A Phloem Necrosis of Elm. Phytopath. 28:757-759. Arborist's News 3(10):1-2.
1614. Swingle, R. U. 1942. Phloem Necrosis: a Virus Disease of the American Elm. Circ. U.S. Dept. Agr. 640. 8 pp.
1615. Swingle, R. U. 1950. Report on Research on the Dutch Elm Disease. Proc. Nat. Shade Tree Conf. 26:38-42.
1616. Swingle, R. U. 1951. Dutch Elm Disease and Control Methods. Arborist's News 16(6):56-58.
1617. Swingle, R. U. 1961. Research on the Development of Elms Resistant to Dutch Elm Disease. Proc. Ann. Conf. DED, Waltham Field Sta., Waltham, Mass. 16:1-3.
1618. Swingle, R. U. and T. W. Bretz. 1950. Zonate Canker, a Virus Disease of American Elm. Phytopath. 40:1018-1022.
1619. Swingle, R. U. and R. R. Whitten. 1952. Dutch Elm Disease. In: Important Tree Pests of the N.W., Edited by Committee on Forest Pest Leaflets, New England Sec. SAF Ed. 2:121-125.
1620. Swingle, R. U. and R. R. Whitten. 1950. Dutch Elm Disease. Tree Pest Leaflets No. 23, Revised June 1950.
1621. Swingle, R. U. et al. 1941. A Transmissible Mosaic of American Elm. Abstr. in Phytopath. 31:22.
1622. Swingle, R. U. et al. 1943. A Graft Transmissible Mosaic of American Elm. Phytopath. 33:1196-1200.
1623. Swingle, R. U. et al. 1945. Phloem Necrosis Research During 1944. Abstr. in Phytopath. 35:489.
1624. Swingle, R. U. et al. 1949. Dutch Elm Disease. USDA Yearbook (Trees). 1949:451-452.
1625. Swingle, R. U. et al. 1949. The Identification and Control of Elm Phloem Necrosis and Dutch Elm Disease. Ohio Agr. Exp. Sta. Special Circ. #80. 11 pp.

1626. Sutton, B. C. and J. G. Laut. 1970. *Graphium penicillioides* on American Elm in Manitoba and Saskatchewan. Can. For. Service, Bi-mon. Res. Note 26:25-26.
1627. Szkolnik, M. 1948. Antagonistic Activity of a Species of Actinomycetes Against *Ceratostomella ulmi* In Vitro. Phytopath. 38:85-87.
1628. Takai, S. 1973. Cerato-ulmin, a Wilting Agent of the Dutch Elm Disease Fungus. In Abstr. Papers Sec. Internat. Congress of Plant Path., Minneapolis:0679.
1629. Takai, S. 1974. Pathogenicity and Cerato-ulmin Production in *Ceratocystis ulmi*. Nature 252(5479):124-126.
1630. Takai, S. and E. S. Kondo. 1972. Seasonal Changes in Susceptibility of White Elm Trees to Dutch Elm Disease in Central Ontario. Proc. Canadian Phytopath Soc. 38:43.
1631. Takai, S. and W. C. Richards. 1972. Isolation of Microstructures Present in Cultures of the Dutch Elm Disease Fungus, *Ceratocystis ulmi*. Applied Microbiology 26:443-444.
1632. Talboys, P. W. 1962. Systemic Movement of Some Vascular Pathogens. Trans. Brit. Mycol. Soc. 45:280-281.
1633. Tarjan, A. C. and F. L. Howard. 1953. Comparison of Benzothiazolyl-2-Thiglycollic Acid Derivatives With Other Chemicals for Dutch Elm Disease Therapy. Abstr. in Phytopath. 53:486.
1634. Taylor, Paul et al. 1971. Synnemata Induction in *Ceratocystis ulmi*. Phytopathology 61:914.
1635. Tchernoff, V. 1963. Vegetative Propagation of Elms by Means of Shoots Cut From Callused Roots. Acta. Bot. Neerl. 12:40-50.
1636. Tchernoff, V. 1963. Verslag van het Onderzoek Betreffende de Iepeziekte Verricht in de Periode van 1 Januari tot 31 December 1963. Phytopath. Laboratorium "Willie Commelin Scholten," Baarn, stencil number 1964/5, 23-1:1-21.
1637. Tchernoff, V. 1966. Methods for Screening and for the Rapid Selection of Elms for Resistance to Dutch Elm Disease. Acta. Bot. Neerl. 14: 409-452.
1638. Tehon, L. R. 1931. The "Elm Wilt" in Illinois Nurseries. Flor. Exch. 76:28, 30, 32.
1639. Tehon, L. R. 1934. Elm Disease in Illinois. Proc. Nat. Shade Tree Conf. 19(1934):105-111.

1640. Tehon, L. R. and H. A. Harris. 1941. A Chytrid Inhabiting Xylem in the Moline Elm. *Mycologia*. 33:118-129.
1641. Tehon, L. R. and H. L. Jacobs. 1936. A *Verticillium* Root Disease of the American Elms. *Bull. Res. Dept. Davey Tree Expert Co.* 6:32 pp. Illustrated.
1642. Tehon, L. R. and H. L. Jacobs. 1936. *Verticillium* Root Disease of American Elms. *Proc. Nat. Shade Tree Conf.* 12(1936):128-40.
1643. Terrier, C. 1945. La Maladie des Ormeaux. *Bull. Murth.* LXII:71-84.
1644. Thomas, J. B. 1971. Smaller European Elm Bark Beetle Found in Sault St. Marie, Ontario. *Can. For. Service, Bi-mon. Res. Notes* 27:3.
1645. Thomas, J. E. and C. A. Bower. 1962. The Occurrence of Dutch Elm Disease in Oklahoma. *Plant Disease Reporter* 46(6):463.
1646. Thomas, W. D. et al. 1948. Dutch Elm Disease in Colorado. *Plant Disease Reporter* 32(7):317.
1647. Thompson, H. E. 1954. The Role of the Native Elm Bark Beetle, *Hylurgopinus rufipes* Eich. in the Transmission of the Dutch Elm Disease Pathogen, *Ceratostomella ulmi* (Schwarz.) Buisman. Ph.D. Diss. Cornell Univ. N.Y.
1648. Thompson, H. E. and J. G. Matthysse. 1972. Role of the Native Elm Bark Beetle, *Hylurgopinus rufipes* Eich. in Transmission of the Dutch Elm Disease Pathogen, *Ceratocystis ulmi* (Buisman) C. Moreau. *Search: Agr. Ent.* 2(1):1-16.
1649. Thompson, H. and S. M. Pady. 1957. Dutch Elm Disease and its Control in Kansas. *Kan. State College, Dept. Ent. Mimeo Circ.* 103 and *Dept. Bot. and Plant Path. Mimeo. Circ.* 12:1-8.
1650. Touhey, J. G. and D. F. Bray. 1961. An Evaluation of Certain Compounds as Feeding Deterrents Against the Smaller European Bark Beetle. *Jour. Econ. Ent.* 54:293-296.
1651. Townsell, Sister M. Mildred Ann. 1968. Life Cycle of *Ceratocystis ulmi*. Single Concept Film. ISU Film Production Unit.
1652. Townsend, Alden M. 1971. Relative Resistance of Diploid *Ulmus* Species to *Ceratocystis ulmi*. *Plant Disease Reporter* 55(11):980-982.
1653. Townsend, A. M. 1975. Crossability Patterns and Morphological Variation Among Elm Species and Hybrids. *Silvae Genetica* 24:18-23.

1654. Townsend, A. M. and L. R. Schreiber. 1975. Recent Progress in the Breeding and Selection of Elms. Proc. C.S.F.T.I.C. 9:1-6.
1655. Trägårdh, I. 1930. Studies on the Galleries of the Bark Beetles. Bull. Ent. Res. 21:469-480. 1930.
1656. Traverso, O. 1934. *Graphium ulmi* la Moria Degli Olmi. (*Graphium ulmi*, the Elm Disease). Bull. R. Soc. Tosc.ortic. 19:78-80, Illustrated.
1657. Truchan, J. G. 1970. Field Evaluation of *Dendrosoter protuberans* as a Biological Control Agent for *Scolytus multistriatus*, the Primary Vector of Dutch Elm Disease. Ph.D. Thesis, Michigan State Univ.
1658. True, R. P. 1941. *Ceratocystis ulmi* Isolated From Elm Wood of Dish Crates Imported From England. Plant Disease Reporter 25:55.
1659. True, R. P. and E. T. Miller. 1936. Dutch Elm Disease in Dead and Dying Elms. Abstr. in Phytopath. 26:110.
1660. True, R. P. and S. S. Slowato. 1939. Scouting and Sampling Elms With the Symptoms Commonly Associated With the Dutch Elm Disease as an Aid in Eradicating *Ceratostomella ulmi*. Phytopath. 29:529-37.
1661. True, R. P. and S. S. Slowato. 1940. Attempts to Isolate *Ceratocystis ulmi* From Stored Elm Wood. Phytopath. 30:272-274.
1662. Tubeuf, C. von. 1920. Absterben der Ulmenäste in Sommer 1920. Naturw. Zeitschr. Forst.-Landw. 18:228-230.
1663. Tubeuf, C. von. 1934. Absterben von Ulmenästen. Zeitschr. Pflanzenkr. 44:423-430.
1664. Tubeuf, C. von. 1935. Werdegang der Erforschung der sog. Ulmen Krankheit in Europa. (Progress in the Investigation of the so-called Elm Disease in Europe.) Ztschr. Pflanzenkr. 45:49-78, 161-189, Feb. and April, 1935.
1665. Tubeuf, C. von. 1936. Die Ulmenkrankheit in München im Sommer 1936. (The Elm Disease in Munich Summer of 1936). Ztschr. Pflanzenkr. 46: 484-507, Illustrated.
1666. Tutunaru, V. 1965. Intensity of Transpiration in *Ulmus foliacea* (*U. carpinifolia*) Infested by *Ophiostoma* (*Ceratostomella ulmi*). Revta. Padurilor 80(7):365-367.

1667. Tyler, L. J. 1945. Influence of Temperature on the Dutch Elm Disease in Potted American Elm. *Phytopath.* 35:302-304.
1668. Tyler, L. J. and K. G. Parker. 1945a. Pathogenicity of the Dutch Elm Disease Fungus. *Phytopath.* 35(4):257-261.
1669. Tyler, L. J. and K. G. Parker. 1945b. Factors Affecting the Saprogenic Activities of the Dutch Elm Disease Pathogen. *Phytopath.* 35:675-687.
1670. Tyler, L. J. et al. 1939. The Relation of *Saperda tridentata* to Infection of American Elm by *Ceratostomella ulmi*. *Phytopath.* 29:547-549.
1671. Tyler, L. J. et al. 1940. Relation of Wounds to Infection of the American Elm by *Ceratocystis ulmi*, and the Occurrence of Spores in Rain Water. *Phytopath.* 30:29-41.
1672. Uffeln. 1928. Die Ulmenkrankheit. (The Elm Disease). *Ent. Ztschr.* 42:201-204.
1673. Upadhyay, H. P. and W. B. Kendrick. 1975. Prodrumus for a Revision of *Ceratocystis* (Microascales, Ascomycetes) and its Conidial States. *Mycologia* 67:798-805.
1674. Uphof, J. C. Th. 1928. Zur Frage der Ulmenkrankheit in Europa. *Zeitschr. Pflanzenkr.* 38:222-224.
1675. U.S.D.A. Bureau of Ent. 1934. (No Title). Its Annual Report of the Chief, 1934. p. 7, (Chief, L.A. Strong).
1676. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1934. Dutch Elm Disease. Its Report of the Chief, 1934. p. 10 (Chief, K. A. Ryerson).
1677. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1935. Announcement Relating to Dutch Elm Disease Quarantine (No. 70). Oct.-Dec. 1934:93-4. 103-4 Mar. 1935. (*Intern. Bull. Plant Prot.* 9:89-90).
1678. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1935. Announcements Relating to Dutch Elm Disease Quarantine (Foreign) (No. 70). Instructions to Collectors of Customs. S.R.A. Jan.-Mar. 1935: 3 May, 1935.
1679. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1935. Announcements Relating to Dutch Elm Disease Quarantine (Domestic) (No. 71). S.R.A. Jan.-Mar. 1935:3-7.
1680. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1935. Current Information on Dutch Elm Disease. *Plant Disease Reporter* 19:273.

1681. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1935. Dutch Elm Disease Eradication. Annual Report of the Chief. pp. 31-4 (Chief L.A. Strong).
1682. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1935. Present Status of the Dutch Elm Disease. Plant Disease Reporter 19:216-218.
1683. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1936. Announcements Relating to Dutch Elm Disease Quarantine. (No. 71). S.R.A. Apr.-Jun. 1936:45.
1684. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1936. Dutch Elm Disease Eradication. Annual Report of the Chief, 1936. pp. 37-42 (Chief L. A. Strong).
1685. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1936. Dutch Elm Disease Eradication. Plant Disease Reporter 19:237-8, 247-8, 259-60, 293, 303, 20:150, 178, 212, 239-40, 267, 294, 322-3, Sept. 1+15, Oct. 1, Nov. 1+15, 1935; May 15, June 15, July 15, Aug. 15, Sept. 15, Oct. 15, Nov. 15, 1936.
1686. U.S.D.A. Bureau of Ent. and Plant Quarantine. 1936. Miscellaneous Notes on Dutch Elm Disease. Plant Disease Reporter 20:322-3.
1687. U.S.D.A. Bureau Ent. and Plant Quarantine. 1936. Announcements Relating to Dutch Elm Disease Quarantine (no. 71). Its S.R.A. Jan.-Mar., 1936:4-5, June, 1936.
1688. U.S.D.A. Bureau Ent. and Plant Quarantine. 1937. Announcements Relating to Dutch Elm Disease Quarantine (no. 71) (Domestic). Its S.R.A. Oct.-Dec., 1936:175-7, Mar., 1937.
1689. U.S.D.A. Bureau of Ent. and Plant Quarantine and Bureau of Plant Indus., Soil and Agr. Eng. 1952. Control of Dutch Elm Disease and Elm Phloem Necrosis. U.S.D.A. Leaflet 329, 11 pp.
1690. U.S.D.A. Bureau of Plant Industry. 1933. Dutch Elm Disease. Report of the Chief, 1933. p. 21 (Chief W. A. Taylor).
1691. U.S.D.A. Bureau of Plant Industry. 1935. Dutch Elm Disease. Report of the Chief, 1935. p. 10 (Chief F. D. Richey).
1692. U.S.D.A. Bureau of Plant Industry. 1936. Elm Disease Research. Report of the Chief. p. 9 (Chief F. D. Richey).
1693. U.S.D.A. Bureau of Plant Quarantine. 1933. Announcements Relating to Dutch Elm Disease. Secretary Wallace Calls Hearing Sept. 15 on Dutch Elm Disease. S.R.A. July-Sept. 1933:197-198.

1694. U.S.D.A. Bureau of Plant Quarantine. 1934. Announcements Relating to Dutch Elm Disease Quarantine (No. 70). Notice of Quarantine No. 70, With Regulations. S.R.A., Oct.-Dec. 1933:245-249, 275-276.
1695. U.S. Dept. of Commerce, Bureau of Foreign and Domestic Commerce. 1931. Statistical Tables of Foreign Commerce of the United States. General Imports....1931. Group 4 - Wood and Paper. Cabinet Wood in the Log. Foreign Commerce and Navigation of the United States, Calendar Year 1931:271.
1696. U.S.F.S. 1972. Cherchez La Femme, Zap!!! Northeastern For. Exp. Sta. Photo Story No. 16.
1697. U.S.F.S. 1972. Shade Tree Insects.
1698. U.S.F.S. 1972. "Tasty Bark" Draws Elm Disease Carrier. USFS Northeast For. Exp. Sta. Photo Story #9.
1699. Valckenier - Suringar, J. 1922. Eine Ulmenkrankheit in Holland. (An Elm Disease in Holland). Mitt. Deut. Dendrol. Ges. 32:145-147.
1700. Valckenier - Suringar, J. 1928. Referaat Over Onderzoekingen Betreffende de Iepenziekte. (Researches About the Elm Disease). Jaarb. Nederl. Dendrol. Vereening 3 (1927):93-104, Illustrated, English Summary.
1701. Valckenier - Suringar, J. 1932. De Iepenziekte. (The Elm Disease). Jaarb. Nederl. Dendrol. Vereenig. 7(1931):190-4.
1702. Valek, Douglas A. 1967. A Study of the Host-parasite Relationships of *Scolytus multistriatus* Marsham and Methods of Propagation for the Introduced Parasite *Dendrosoter protuberans* (Nees) Wesm. M.S. Thesis, Michigan State University., East Lansing.
1703. Valjda, Z. 1952. Uzroci Eipдемијskeg Ugibamga Brijestova. (Cause of the Mass Deterioration of Elms). Glasn. Sumske Pokuse No. 10. 105-197.
1704. Van Alfen, N. K. and G. S. Walton. 1974. Pressure Injection of Benomyl and Methyl-2-Benzimidazole Carbamate Hydrochloride for Control of Dutch Elm Disease. Phytopath. 64(9):1231-1234.
1705. Van Alfen, N. K. and G. S. Walton. 1974. An Evaluation of the Lowden Formulation Containing Nystatin for Dutch Elm Disease Control. Plant Disease Reporter 58(10):924-926.
1706. Vancamp, J. C. 1963. Status of Dutch Elm Disease. A Panel Discussion. Outlook in Midwest and Fringe Area. Internatl. Shade Tree Conf. Proc. 39:143-149.

1707. Vancamp, J. C. 1963. What Dutch Elm Disease has Done to Illinois. *Arborist's News* 28(5):33-38.
1708. Verrall, A. F. 1930. Die-back of Elms in Minnesota. *Phytopath.* 12: 1004-1005.
1709. Verrall, A. F. 1935. *Cephalosporium* Die-back of Elms. *Plant Disease Reporter Supplement* 90:100.
1710. Verrall, A. F. 1936. *Cephalosporium* Die-back of Elms. *Plant Disease Reporter Supplement* 96:256.
1711. Verrall, A. F. 1938. The Longevity of *Ceratostomella ulmi* in Soils. *Phytopath.* 28:763-765.
1712. Verrall, A. F. and T. W. Graham. 1935. The Transmission of *Ceratostomella ulmi* Through Root Grafts. *Phytopath.* 25(11):1039-1040.
1713. Verrall, A. F. and C. May. 1937. A New Species of *Dothiorella* Causing Die-back of Elm. *Mycologia* 29:321-324.
1714. Voightlander, B. 1927. Bekämpfung des Ulmensterbens Durch Impfen in Hamburg. (Control of the Elm Disease by Vaccination in Hamburg). *Mollers Deut. Gart.-Ztg.* 42:240-242, Illustrated.
1715. Wadley, F. M. and D. O. Wolfenbarger. 1944. Regression of Insect Density on Distance From Center of Dispersion as Shown by a Study of the Smaller European Elm Bark Beetle. *Jour. Agr. Res.* 69:299-308.
1716. Waksman, S. A. and E. Bugie. 1943. Action of Antibiotic Substances Upon *Ceratostomella ulmi*. *Proc. Soc. Exp. Biol. and Med.* 54:79-82.
1717. Walker, E. A. 1946. Spread of the Dutch Elm Disease in Maryland. *Abstr. in Phytopath.* 36:689.
1718. Wallace, G. J. et al. 1961. Bird Mortality in Dutch Elm Disease Program in Michigan. *Cranbrook Inst. Sci. Bull.* 41, 44 pp.
1719. Wallace, H. A. and A. S. Hoyt. 1933. Dutch Elm Disease Quarantine. Notice of Quarantine No. 70 With Regulations. U.S.D.A. Bureau of Plant Quarantine: 1-4.
1720. Wallace, P. P. 1940. Notes on the Smaller European Elm Bark Beetle. *Conn. Agri. Exp. Sta. Bull.* 434:293-311.
1721. Wallace, P. P. 1943. Observations of Elm Twig-crotch Feeding by *Scolytus multistriatus* Marsh. *Conn. Agr. Exp. Sta. Bull.* 472: 290-291.

1722. Wallace, P. P. and R. L. Beard. 1943. The Effect of Low Temperatures Upon Mortality of the Larvae of *Scolytus multistriatus* Marsham. Conn. Agri. Exp. Sta. Bulletin 472.
1723. Wallace, P. P. and D. Labelle. 1943. Dutch Elm Disease Sample Plots, 1942. Conn. Agr. Exp. Sta. Bull. 472:285-287.
1724. Wallace, P. P. and G. A. Zentmyer. 1944. The Development of Dutch Elm Disease in Southwestern Connecticut. Conn. Agr. Exp. Sta. Bull. 481:299-300.
1725. Wallner, W. E. and J. H. Hart. 1965. Dutch Elm Disease Control. Extension Bulletin, Michigan State University, East Lansing No. 506.
1726. Wallner, W. E. and J. H. Hart. 1968. Dutch Elm Disease Control. Extension Bulletin 506 (Revised). Mich. State Univ., East Lansing.
1727. Wallner, W. E. and N. C. Leeling. 1968. Helicopter Application of Methoxychlor for Elm Bark Beetle Control. Michigan State University, Quart. Bull. 50(1968):416-422.
1728. Wallner, W. E. et al. 1969. The Fate of Mehtoxychlor Applied by Helicopter for Smaller European Elm Bark Beetle Control. J. Econ. Ent. 62:1038-1042.
1729. Walter, J. M. 1935. Technique Advantageous for the Isolation of *Ceratostomella ulmi* From Bark Beetles. Phytopath. 25:37-38.
1730. Walter, J. M. 1937. Variation in Mass Isolates and Monoconidium Progenies of *Ceratostomella ulmi*. Jour. Ag. Res. 54(7):509-523.
1731. Walter, J. M. 1939a. Effects of *Ceratostomella ulmi* on *Ulmus americana* and Some Types of European Elm. Abstr. in Phytopath. 29:23.
1732. Walter, J. M. 1939b. Observations on Fructification of *Ceratostomella ulmi* in England. Phytopath. 29:551-553.
1733. Walter, J. M. and C. May. 1937. Pathogenicity of a Brown Cultural Variant of *Ceratostomella ulmi*. Phytopath. 27:142.
1734. Walter, J. M. et al 1943. Dutch Elm Disease and its Control. U.S.D.A. Circ. #677.
1735. Waters, W. E. and R. W. Brandt. 1970. Trees for People or Pests. American Forests 21:23-51.

1736. Watson, E. B. 1948. The European Elm Bark Beetle Forest Insect Inventory. Bi-mon. Prog. Rep. Can. Dept. Agr. 4(5):2.
1737. Watson, W. Y. and W. L. Sippell. 1961. Scolytid Vectors of the Dutch Elm Disease in Ontario. Can. Ent. 93:403-405.
1738. Weber, P. V. V. et al. 1974. New In New Jersey: Elm Phloem Necrosis. Plant Disease Reporter 58(5):387.
1739. Weber, R. 1969. The Native Elm Bark Beetle in Northern Wisc., 1968-1969. In Ann. Rept. For. Pest Conditions in Wisconsin.
1740. Wechel, A. te. 1934. Houtverlies Tengevolge van het Schillen van Iepenhout op de Opslagplaatsen. (Loss of Wood in Consequence of the Scaling of Elm at the Felling Sites). Nederl. Boschb.-Tijdschr. 7:64-72, Illustrated.
1741. Weidhaas, J. A., Jr. 1967. Insecticides in Relation to Dutch Elm Disease Control. Arborist's News 32(6):41-46.
1742. Weihing, J. L. 1960. Identification of Dutch Elm Disease. Am. Rep. Coop. Ext. Work in Agr. and Home Econ. Univ. of Neb., 1960:17.
1743. Weiss, A. 1931. Ist der Pilz *Graphium* die Ursache des Ulmensterbens? (Is the Fungus *Graphium* the Cause of Die-back of Elms?) Gartenwelt. 35(48):657-658.
1744. Welch, D. S. 1946. Dutch Elm Disease Controlled by Cleanup of Breeding Areas. Exper. Sta. Record 94:781.
1745. Welch, D. S. 1953. Dutch Elm Disease in Urban and Forest Areas. Jour. For. 51(9).
1746. Welch, D. S. 1959. Research on Disease Resistance in American Elms in the Cornell Plantations. N.Y. Sta. Arborists Ass. Shade Tree Notes (71):5-6.
1747. Welch, D. S. and D. L. Collins. 1940. Dutch Elm Disease and its Control. N.Y. Agr. Exp. Sta. (Cornell) Bull. 437.
1748. Welch, D. S. and J. G. Matthysse. 1955. Control of the Dutch Elm Disease in New York State. Cornell Ext. Bull. 932. 14 pp.
1749. Welch, D. S. et al. 1934. The Dutch Elm Disease. Cornell Extension Bull. 290:1-19.
1750. Welch, D. S. et al. 1935. The Dutch Elm Disease. Cornell Agr. Sta. Ann. Report. 48:115.

1751. Welch, D. S. et al. 1945. Dutch Elm Disease Control. Cornell Ext. Bull. 687.
1752. Welch, R. C. 1974. Dutch Elm Disease in Huntingdonshire - The Third Year. In 26th Annual Report for 1973, Huntingdonshire Fauna and Flora Soc. p. 11-14.
1753. Went, J. C. 1937. Verslag van de Onderzoekingen Betreffende de Iepen-ziekte, Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn Gedurende 1936. (Report on the Elm Disease Investigations Carried on at the Phytopathological Center **** at Baarn in 1936). Tijdsch. Plantenz. 43:75-90.
1754. Went, J. C. 1938. Compilation of the Investigation on the Susceptibility of Different Elms to *Ceratostomella ulmi* (Buisman) in the Netherlands. Phytopath. Zeit. XI:181-201.
1755. Went, J. C. 1939. Report on the Elm Disease. "Willie Commelin Scholten," Phytopathological Lab., Baarn During 1938. Tijdschr. Pflziekt. 45 (2):52-62.
1756. Went, J. C. 1940. Verslag van de Onderzoekingen Over Iepen-ziekte, Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn Gedurende 1939. Comité Inzake Besturdeeringen Bestrijding van de Iepen-ziekte Meded. 40:5-14.
1757. Went, J. C. 1946. Verslag van de Onderzoekingen Over Iepen-ziekte, Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn Gedurende 1939. Meded. Inst. Toegep. Biol. Orderz. Natuur. 41:5-24.
1758. Went, J. C. 1947. Verslag van de Onderzoekingen Over het Iepen-ziekte, Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn Gedurende 1939. H. Veerman and Zonen, Wageningen. 1941-1944. pp. 22.
1759. Went, J. C. 1947. Verslag van de Onderzoekingen Over het Iepen-ziekte, Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn Gedurende 1940. Ibid. pp. 8.
1760. Went, J. C. 1947. Verslag van de Onderzoekingen Over het Iepen-ziekte, Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn Gedurende 1941. Ibid. pp. 10.
1761. Went, J. C. 1947. Verslag van de Onderzoekingen Over het Iepen-ziekte, Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" to Baarn Gedurende 1942. Ibid. pp. 14.

1762. Went, J. C. 1947. Verslag van de Onderzoekingen Over het Iepenziekte, Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn Gedurende 1943. Ibid. pp. 14.
1763. Went, J. C. 1947. Verslag van de Onderzoekingen Verricht in 1946 Voor het Comite Inzake Bestudeering en Bestrijding van de Iepenziekte en Andere Boomziekten, Uitgevoerd op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn. (Report on the Research Carried out in 1946 on Behalf of the Committee for the Study and Control of Elm Disease and Other Tree Diseases, at the "Willie Commelin Scholten" Phytopathological Laboratory, Baarn.) Meded. Iepenziektecomite, Baarn. 42, 1947.
1764. Went, J. C. 1948. (Report on the Investigation on the Elm Disease and Other Tree Diseases Conducted at the "Willie Commelin Scholten" te Baarn Gedurende 1947). Meded. Iepen. Baarn. 43:1-15.
1765. Went, J. C. 1949. (Report on the Investigations on the Elm Disease and Other Tree Diseases Conducted at the "Willie Commelin Scholten" te Baarn Gedurende 1947). Meded. Inst. Toegep. Biol. Onderz. Nat. 44:1-15.
1766. Went, J. C. 1951. (Report on the Investigation on the Elm Disease and Other Tree Diseases Conducted at the "Willie Commelin Scholten" te Baarn Gedurende 1947). Ibid. 46:1-16.
1767. Went, J. C. 1952. (Report on the investigations on the Elm Disease and Other Tree Diseases Conducted at the "Willie Commelin Scholten" te Baarn Gedurende 1947). Ibid. 47:1-5.
1768. Went, J. C. 1954. The Dutch Elm Disease - Summary of Fifteen Years Hybridisation and Selection Work (1937-1952). Tijdschr. Plziekt. 60:109-127.
1769. Wertz, H. W. et al. 1971. *Ceratocystis fagacearum* not Transmitted by Ambrosia Beetles. Phytopathology 61(10):1185.
1770. Westenburg, J. 1931. La Maladie de l'Orme en Auvergne. (The Elm Disease in Auvergne). Rev. Path. Veg. and Entom. Agr. 18:24-28, Illustrated.
1771. Westenburg, J. 1932. Uit de Historie de *Graphium*-ziekte in de Iepen. (Concerning the History of the *Graphium* Disease of Elm). Tijdschr. Plantenz. 38:61-6, Eng. Summary.
1772. Wester, Horace. 1972. Investigations of American Elm Clones Based on Physiological Vigor for Crown Resistance to Dutch Elm Disease. Plant Disease Reporter 56(8):725-728.

1773. Wester, H. V. and E. W. Jylkka. 1959. Elm Scorch Graft Transmissible Virus of American Elm. Plant Disease Reporter 43:519.
1774. Wester, H. V. and E. W. Jylkka. 1963. High Incidence of Dutch Elm Disease in American Elms Weakened by Elm Scorch Associated With Breeding Attacks of *Scolytus multistriatus*. Plant Disease Reporter 47(6): 545-547.
1775. Westerdijk, J. 1928. Is de Iepen ziekte een Infectie ziekte? Separate: Tijdschr. d. Nederl. Heid. 1928. Afl. 10:1-5.
1776. Westerdijk, J. 1928. Bericht Über die Ulmenuntersuchung. (Report on the Elm Research). Festschr. Nederl. Heid. 1928:594-6.
1777. Westerdijk, J. 1929. I Vroegere Onderzoekingen en Algemeene Buschouwingen. De Iepen ziekte:1-12.
1778. Westerdijk, J. 1933. Kort Verslag Over het Iepen ziekte-onderzoek Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn. Gedurende het Jaar 1932. (Short Report on the Elm Disease Research of the "Willie Commelin Scholten" Laboratory During 1932). Tijdschr. Plantenz. 39:17-20.
1779. Westerdijk, J. 1934. (Short Report on the Elm Disease Research of the "Willie Commelin Scholten" Laboratory During 1934). Tijdschr. Plantenz. 41:101-103.
1780. Westerdijk, J. 1936. In Memoriam Dr. Christine Johanna Buisman. Tijdschr. Plantenz. 43:175-8, Illustrated.
1781. Westerdijk, J. 1944. Kort Verslag, Tevens Samenvatting van de Onderzoekingen Over Iepen ziekten, Verricht op het Phytopathologisch Laboratorium "Willie Commelin Scholten" te Baarn Gedurende 1943. Comité Inzake Bestudeering en Bestrijding van de Iepen ziekte Meded. 39:4.
1782. Westerdijk, J. and C. Buisman. 1929. (The Elm Disease) Nederland. Heide Maatsch. 78 pp.
1783. Westerdijk, J. et al. 1931. (Notes on the Testing of Elms for Susceptibility to *Graphium ulmi* Schwarz., During 1929 and 1930). Tijdschr. Over Plantenz. 37:105-110.
1784. Westerdijk, J. et al. 1932. (What Can Dutch Arborists do in Connection With Elm Disease?). Tijdschr. Over Plantenz. 38:37-40.
1785. Wharten, W. P. 1938. Are the Elms Being Saved? Amer. Forests XLIV:545.

1786. White, J. A. 1974. Dutch Elm Disease - Practical Application and Control. Summary of R.C.G.A. National Turfgrass Conference. pp. 46-47.
1787. White, L. T. 1961. Dutch Elm Disease and its Control. Inf. Bull. Ont. Dept. Lands and Forests.
1788. White, L. T. 1963. (Unpublished). Distribution and Severity of Dutch Elm Disease. 1st Symposium on Shade Trees, Toronto.
1789. White, R. P. 1930. The Dutch Elm Disease. The Shade Tree (N.J.), 3:(2-7).
1790. White, R. P. 1933. The Dutch Elm Disease. Flor. Exch. 81:17.
1791. White, R. P. 1933. The Dutch Elm Disease. N.J. Agr. 15:1.
1792. White, R. P. 1933. The Dutch Elm Disease in New Jersey. Nat. Shade Tree Conf. 9:105-110.
1793. White, R. P. 1933. The Dutch Elm Disease Situation. The Shade Tree, No. 12. 6:2-3.
1794. White, R. P. 1934. Report on Dutch Elm Disease. Proc. Amer. Assoc. Nur. 59(1934):103-105.
1795. White, R. P. 1934. The *Cephalosporium* Wilt and Die-back of Elm. N.J. Agr. Exp. Sta. Nurs. Dis. Notes 7:23-8.
1796. White, R. P. 1934. The Dutch Elm Disease Situation. Flor. Exch. 3(83): 19.
1797. White, R. P. 1934. The Shade Tree Commission and the Dutch Elm Disease. The Shade Tree 1(7):2-3.
1798. White, R. P. 1935. Progress of Dutch Elm Disease Eradication. Plant Disease Reporter 19:270-273.
1799. White, R. P. 1935. The Dutch Elm Disease. New Jersey Agr. 17:4.
1800. White, R. P. 1935. The Dutch Elm Disease in New Jersey. The Shade Tree 11(8):11-12.
1801. White, R. P. 1936. Status of the Dutch Elm Disease. Plant Disease Reporter 20:263-266.
1802. White, R. P. 1936. The Dutch Elm Disease. Gard. Chron. of Amer. 40:323, 334-5.

1803. White, R. P. et al. 1933. The Dutch Elm Disease in New Jersey. Plant Disease Reporter 17:107-109.
1804. White, R. P. et al. 1933. The Dutch Elm Disease in New Jersey and New York. Plant Disease Reporter 17:115-117.
1805. Whitten, R. R. 1941. The Internal Applications of Chemicals to Kill Elm Trees and Prevent Bark Beetle Attack. U.S.D.A. Circ. #605.
1806. Whitten, R. R. 1945. Preliminary Experiments With DDT in 1944 for the Control of the Smaller European Elm Bark Beetle. U.S.D.A. Bureau Ent. and Plant Quarantine Mimeo. E. Series, no. 670.
1807. Whitten, R. R. 1953. Elm Bark Beetles. U.S.D.A. Leaflet No. 185.
1808. Whitten, R. R. 1956. Elm Disease Sprays, Formulas and Ingredients. U.S.D.A. For. Ser. Bulletin.
1809. Whitten, R. R. 1956. Protecting Against Dutch Elm Disease. U.S.D.A. Central States Forest Experiment Sta., Misc. Release #10.
1810. Whitten, R. R. 1956. The Dutch Elm Disease and its Control. U.S.D.A. Agr. Infor. Bull. #193.
1811. Whitten, R. R. 1963. Elm Bark Beetles. U.S.D.A. Leaflet 185, Revised.
1812. Whitten, R. R. and D. E. Parker. 1946. Experimental Control of Shade Tree Insects With DDT. Proc. 21st Shade Tree Conf. 1945:13-17.
1813. Whitten, R. R. and R. U. Swingle. 1948. The Status of Research on Two Epidemic Elm Diseases. Nat. Shade Tree Conf. Proc. 24:113-120.
1814. Whitten, R. R. and R. U. Swingle. 1958. The Dutch Elm Disease and its Control. U.S.D.A. Agr. Inform. Bull. 193, 12 pp.
1815. Whitten, R. R. and R. U. Swingle. 1964. The Dutch Elm Disease and its Control. U.S.D.A. Agr. Info. Bull. 193.
1816. Wildeman, E. de. 1933. A Propos de la Maladie des Ormes. (On the Elm Disease). Bull Soc. Roy. Bot. Belgique 65 (Ser. II, 15):107-8.
1817. Williams, L. H. 1967. Biology and Control of *Scolytus multistriatus* Marsham in Missouri. M.S. Thesis, Univ. Missouri. 136 pp.

1818. Williams, L. H. and H. E. Brown. 1969. Some Biological Investigations of the Smaller European Elm Bark Beetle in Missouri With Reference to Systemic Insecticidal Control. Jour. Econ. Ent. 62:1381-1386.
1819. Willis, W. G. 1964. Dutch Elm Disease in Kansas in 1963. Plant Disease Reporter 48(3):324.
1820. Willis, Will G., 1972. Benlate for Dutch Elm Disease Control. Kansas State Univ. Handout.
1821. Willis, W. G. et al. 1963. Dutch Elm Disease in Kansas in 1962. Plant Disease Reporter 47:443.
1822. Willis, W. G. et al. 1965. Dutch Elm Disease in Kansas in 1964. Plant Disease Reporter 49:359.
1823. Wilson, C. L. 1963. Dutch Elm Disease (*Ceratocystis ulmi*) Survey in Arkansas in 1962. Plant Disease Reporter 47(5):442.
1824. Wilson, C. L. 1965. *Ceratocystis ulmi* in Elm Wood. Phytopath. 55:477.
1825. Wilson, C. L. 1967. Presence of Two Tree Vascular Diseases Confirmed in Arkansas. Plant Disease Reporter 53:79.
1826. Wilson, C. L. 1971. Elm Phloem Necrosis is Waiting in the Wings. Arborist's News 36(9):97-99.
1827. Wilson, C. L. 1972. Lab Seeks Solutions to Tree Problems. Weeds Trees and Turf 11(2):44.
1828. Wilson, C. L. 1975. The Long Battle Against Dutch Elm Disease. Jour. of Arboriculture 1:107-113.
1829. Wilson, C. L. and M. C. Tucker. 1966. Dutch Elm Disease now Epidemic in Arkansas. Ark. Farm Research 15:5.
1830. Wilson, C. L. et al. 1961. Dutch Elm Disease in Arkansas. Plant Disease Reporter 45:900.
1831. Wilson, C. L. et al. 1967. Dutch Elm Disease Distribution in Arkansas. 1966. Plant Disease Reporter 51:71.
1832. Wilson, C. L. et al. 1972. Mycoplasma-like Bodies Associated With Elm Phloem Necrosis. Phytopathology 62:140-143.
1833. Wilson, Malcom. 1927. The Dutch Elm Disease. Gard. Chron. 81:133-34.

1834. Wilson, M. and M. J. F. Wilson. 1928. The Occurrence of the Dutch Elm Disease in England. Gard. Chron. 83:31-32.
1835. Wilson, M. and M. J. F. Wilson. 1938. (No Title) Proc. Linn. Soc. London 140(1927-28):32-4.
1836. Wilson, M. J. F. 1929. Uber das Ulmensterben und Seinen Erreger. Zeitschr. Pflanzenkr. 39:36-39.
1837. Wisconsin Department of Agr. 1962. Dutch Elm Disease - Report 1961.
1838. Wisconsin, University of. 1972. Dutch Elm Disease Systemic Fungicide (Benlate) Seminar. College of Agri. Publ.
1839. Wisconsin, Univ. of. 1973. 1973 Wisconsin Dutch Elm Disease Systemic Fungicide (Benlate) Handbook. Univ. of Wisc. College of Agri. and Life Sciences and Ext. Wisc. Counties Cooperating. 55 pp.
1840. Witcher, W. 1971. Dutch Elm Disease in South Carolina. Plant Disease Reporter 55(2):158.
1841. Witte, C. P. 1936. Trees Available for Street Planting. The Shade Tree (N.J.) 9:(1-3). See pp. (2-3).
1842. Wolfe, R. D. and C. L. Hatch. 1969. Dutch Elm Disease Detected in Mississippi. Plant Disease Reporter 53:3.
1843. Wolfenbarger, D. O. 1945. Estimations of Volumes, Surface Areas and Numbers of Twig Crotches in Elm Trees. Amer. Mid. Nat. 34:421-432.
1844. Wolfenbarger, D. O. and W. D. Buchanan. 1939. Notes on Elm Twig Crotch Injuries Produced by *Scolytus multistriatus* Marsham. Jour. Econ. Ent. 32:377-381.
1845. Wolfenbarger, D. O. and T. H. Jones. 1943. Intensity of Attacks by *Scolytus multistriatus* at Distances From Dispersion and Convergence Points. Jour. Econ. Ent. 36:399-402.
1846. Wollenweber, H. W. 1927. Das Ulmensterben und Sein Erreger, *Graphium ulmi* Schwarz. (The Elm Disease and its Cause). Nachrichtenbl. Deut. Pflanzen. 7:97-100, Illustrated.
1847. Wollenweber, H. W. 1927. Elm Blight and its Cause *Graphium ulmi* Schwarz. News for German Plant Protection Service, #10; Translated by Lillian D. Kelsey in Bartlett Research Lab. Bull. #1:26-31.
1848. Wollenweber, H. W. 1929. Chinosol Gegen Schadhliche Pilze. (Chinosol as a Fungicide). Angew. Bot. 11:116-120.

1849. Wollenweber, H. W. 1929. Das Ulmensterben. (The Elm Disease). Blumen-u. Pflanzenbau. 44:40-41, Illustrated.
1850. Wollenweber, H. W. 1929. Die Wirtelpilz-welkekrankheit (Verticilliose) von Ulme, Ahorn und Linde usw. (On the Verticilliosis of Elm, Maple, Linden, etc.) Arb. Biol. Ruchsanst. Land.-u. Forstw. 17: 273-99.
1851. Wollenweber, H. W. 1929. Das Ulmensterben und Sein Erreger (*Graphium ulmi* Schwarz). (The Elm Disease and its Cause ****). Biol. Reichsanst. Land. u. Forstw., Flugbl. 94:1-4, June, 1929.
1852. Wollenweber, H. W. 1930. Germany: Present State of "Elm Disease". Intern. Bull. Plant Prot. 4:1-2.
1853. Wollenweber, H. W. 1930. Über den Geganwartigen Stand des Ulmensterbens. Mitt. Deut. Dendr. Ges. 43:334-335.
1854. Wollenweber, H. W. 1931. La Maladie de l'Orme. Congress Internat. Bois. et Sylvicult. Paris Rapports, Groupe II. pp. 603-604.
1855. Wollenweber, H. W. 1932. Das Ulmensterben und Sein Erreger. Biol. Reichs. Land-Forstw. No. 94, 2 Auf:1-4 f. 1-5.
1856. Wollenweber, H. W. 1932. *Graphium*. In Sorauer's Handbuch der Pflanzenkrankheiten. 3(2):718-26, Illustrated ed. 5 Berlin 1932.
1857. Wollenweber, H. W. 1936. Christine Johanna Buisman Zum Gedachtnis. (In Remembrance of Christine Johanna Buisman). Angew. Bot. 18: 337-8.
1858. Wollenweber, H. W. 1937. Zurabnehr des Ulmensterbens. Forsch. Deutsch. Fortschr. Wiss.13(20-21):251-252.
1859. Wollenweber, H. W. and J. G. Betrem. 1930. Mitteilungen über das Ulmensterben. Mitt. Deut. Dendrol. Ges. 43:334-6.
1860. Wollenweber, H. W. and H. Richter. 1930. (Status of the Die-back of Elms in the Year 1930 in Germany). Nachr. Deutsch. Pflanz. 10:83-84.
1861. Wollenweber, H. W. and H. Richter. 1931. Infektionsversuche mit *Graphium ulmi* on Ulmen und Anderen Laubbaumen. (Inoculation Experiments With *Graphium ulmi* on Elms and Other Deciduous Trees). Nachrichtenbl. Deut. Pflanzenschutz 11:89.
1862. Wollenweber, H. W. and K. Roder. 1938. Das Verhalten Einer Pfropfulme (*Ulmus pumila*) Gegen *Graphium ulmi*. Nachr. Bl. Dtsch. Pflschdienst. XVIII:31-32.

1863. Wollenweber, H. W. and K. Roder. 1942. Uber Die Wilderstandfahigkeit der Ulme "Christine Buisman" Gegan *Graphium ulmi*. Ztschr. f. Pflanzenkr. 52:515.
1864. Wollenweber, H. W. and C. Stapp. 1928. (Investigations on the Tree Disease Known as Die-back of Elms). Arb. Biol. Reich. fur land and Forst. 16:283-324.
1865. Woodring, J. P. and J. C. Moser. 1970. Six New Species of Anoetic Mites Associated With North American Scolytidae. Can. Ent. 102:1237-1257.
1866. Woods, A. C. 1972. Phosphatidase and Polygalacturonase in Extracts of Diseased and Healthy American Elms and in Cultures of *Ceratocystis ulmi*. Univ. of Mass. M.S. Thesis Dec. 1972: 65 pp.
1867. Woods, A. C. and F. W. Holmes. 1974. Extraction of Fluid From Healthy and Dutch Elm Diseased Branches Using Hydraulic Compression. Phytopath. 64(9):1265-1266.
1868. Woodward, Carol H. 1933. Surveying for Dutch Elm Disease. Jour. N.Y. Bot. Gard. 34:222-224.
1869. Wooten, J. F. 1962. Methoxychlor Safe and Effective Substitute for DDT in Controlling Dutch Elm Disease. USFS Central States Forest Exp. Sta. Station Note 156.
1870. Worf, G. et al. 1975. Treating Dutch Elm Disease With Benlate. Urban Phytovarian Series A2516. U.W. Madison. May, 1975.
1871. Worthley, L. H. 1934. The Present Status of Dutch Elm Disease Control Activities in the United States. USDA Bur. Ent. and Plant Quar. Dutch Elm Disease Control. 7 pp. (Mimeo).
1872. Worthley, L. H. 1935. Dutch Elm Disease must be Eradicated to Save American Elm. U. S. Dept. Agr. Yearbook 1935 (for 1934):174-175, illustrated.
1873. Worthley, L. H. 1935. Status of Dutch Elm Disease Eradication. Nat. Shade Tree Conf. 11:111-122.
1874. Worthley, L. H. 1935. The Dutch Elm Disease Eradication Project: Federal, State and Local Cooperation. USDA Circ. 353:1-4.

1875. Worthley, L. H. 1936. Progress in Dutch Elm Disease Eradication. Jour. Econ. Ent. 29(1):176-181.
1876. Worthley, L. H. 1936. Summary of Japanese Beetle and Dutch Elm Disease Activities for 1935. Central. Plant Bd. Proc. 12(1936):10-14. (Mimeo).
1877. Worthley, L. H. and O. N. Liming. 1935. Dutch Elm Disease Eradication in the United States. Jour. Econ. Ent. 28:524-28.
1878. Worthley, L. H. et al. 1935. Dutch Elm Disease. Mimeo Report of U.S. Seminar. SAP 1935. White Plains.
1879. Wurster, C. F., Jr. et al. 1965. Bird Mortality After Spraying for Dutch Elm Disease With DDT. Science 148:3666.
1880. Wysong, D. S. and G. W. Peterson. 1966. Known Distribution of Dutch Elm Disease (*Ceratocystis ulmi*) in Nebraska. Plant Disease Reporter 50(8):618.
1881. Wysong, David S. and Robert Roselle. 1967. Dutch Elm Disease--Its Cause and Prevention in Nebraska. University of Nebraska. Extension Service. EC67-1845, 10 pp.
1882. Wysong, D. S. and W. G. Willis. 1968. Recorded Distribution of Dutch Elm Disease West of the Mississippi River as of 1967. Plant Disease Reporter 52:652-653.
1883. Young, H. O. 1934. The Dutch Elm Disease. Ohio Agr. Exp. Sta. Bull. 532 (Ann. Report 52):38.
1884. Zabka, J. 1933. Grafiosa Jilmo a Volba Nahradni Dreviny. (The Damage of **** to Elms and the Choice of Additional Species). Lesnicka Prace (L'Oeuvre For.). 12:540-45.
1885. Zanoni, G. 1932. La Moria Degli Olmi e i Sostegni Viva della Vite. (Disease of the Elms, the Living Supports of the Vines). Riv. Agr. (Rome). 28:318.
1886. Zaronsky, C., Jr. and R. J. Stipes. 1969. Some Effects on Growth and Translocation of Thiabendazole (TBZ) + (BBC) Applied to *Ulmus americana* Seedlings. Phytopathology 59:1562.
1887. Zentmyer, G. A. 1942a. Toxin Formation and Chemotherapy in Relation to Dutch Elm Disease. Abstr. in Phytopath. 32:20.

1888. Zentmyer, G. A. 1942b. Toxin Formation by *Ceratostomella ulmi*. Science 95:512-513.
1889. Zentmyer, G. A. 1943. Mechanism of Action of 8-hydroxyquinoline. Abstr. in Phytopath. 33:1121.
1890. Zentmyer, G. A. 1943. Vascular Chemotherapy. Trees 6:7, 16-17.
1891. Zentmyer, G. A. and J. G. Horsfall. 1943. Internal Therapy With Organic Chemicals in Treatment of Vascular Disease. Abstr. in Phytopath. 33:16.
1892. Zentmyer, G. A. and P. P. Wallace. 1944. Factors Influencing the Development of *Ceratostomella ulmi* in Elm Trees. Abstr. in Phytopath. 34:1014.
1893. Zentmyer, G. A. and P. P. Wallace. 1944. New Research on Dutch Elm Disease. Nat. Shade Tree Conf. Proc. 20:115-119.
1894. Zentmyer, G. A. et al. 1943. Logarithmic-probit Relation of Spore Dosage and Response in Dutch Elm Disease. Abstr. in Phytopath. 33:1121.
1895. Zentmyer, G. A. et al. 1944. Dutch Elm Disease and its Chemotherapy. Conn. Agr. Exp. Sta. 498.
1896. Zentmyer, G. A. et al. 1944. Distance as a Dosage Factor in the Spread of Dutch Elm Disease. Phytopathology 34:1025-1033.
1897. Ziegner, P. B. 1928. Die Ursachen des Ulmensterbens. (The Cause of the Elm Disease). Gartenwelt. 32:133.
1898. Zijst, C. von. 1924. Iepenziekte. (Elm Disease). Floralia 45:573.
1899. Zillig, H. 1942. Beitrage zur Adventieflora des Moselgebietes. (Contributions to the Exotic Flora of the Moselle Region). Angew. Bot. XXIV:352-393.
1900. Zimmerman, M. H. 1964. Sap Movement in Trees. Biorheology 2:15-27.
1901. Zudilin, V. A. 1969. (Investigations on the Resistance of Elms to Dutch Elm Disease). Lesn. Hoz. 3:62-4.
1902. Zuklys, L. 1958. (Dutch Elm Disease in the Lithuanian S. S. R. and Control Measures). Darb. Liet. Mis. Uk. Moks. Tyr. Inst. Kaunas. 3:155-185.

DUTCH ELM DISEASE AND ITS CONTROL



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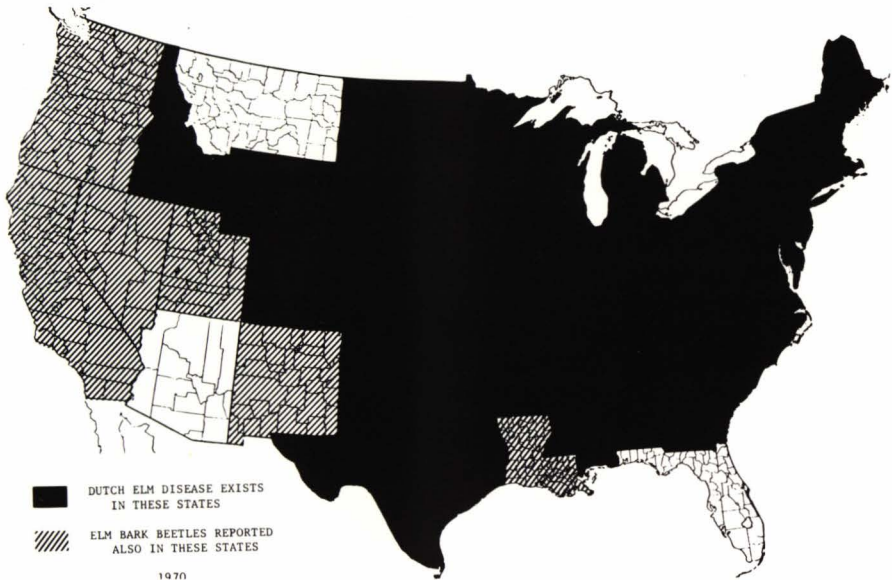
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Background

Dutch elm disease was discovered in Ohio in 1930 and around the Port of New York in 1933. The causal fungus was introduced on elm-veneer logs imported from Europe. Soon the disease appeared along railroad rights-of-way and at ports of entry. Since then, it has spread until it has been reported in 38 states from the east coast west to Idaho, Colorado, and Texas and from three provinces of Canada south to Mississippi, Alabama, and Georgia (fig. 1). The disease has caused extremely heavy losses of both wild elms and those planted as ornamentals. It is the most destructive shade-tree disease in North America. Dutch elm disease is caused by the fungus *Ceratocystis ulmi* (Buisman) C. Moreau. The fungus attacks native and some exotic species of elm. Plants in the related genera, *Zelkova* and *Planera*, have become diseased when artificially inoculated with the fungus.

Figure 1.—Distribution of the Dutch elm disease and its principal carrier in 1970.



Highlights

The principal carrier of the Dutch-elm-disease fungus in the United States is the smaller European elm bark beetle. The best way to control Dutch elm disease is to control the fungus carriers. There is no known cure once an elm tree becomes infected by Dutch elm disease.

The effectiveness of any control program depends on how well the following four control procedures are carried out.

1. Sanitation will reduce elm bark beetle populations and reservoirs of the fungus. Control of elm bark beetles by sanitation should be started as soon as they are found in an area. This may delay the occurrence of Dutch elm disease and reduce the severity of it.

2. Spraying healthy elm trees should supplement the use of sanitation for Dutch elm disease control.

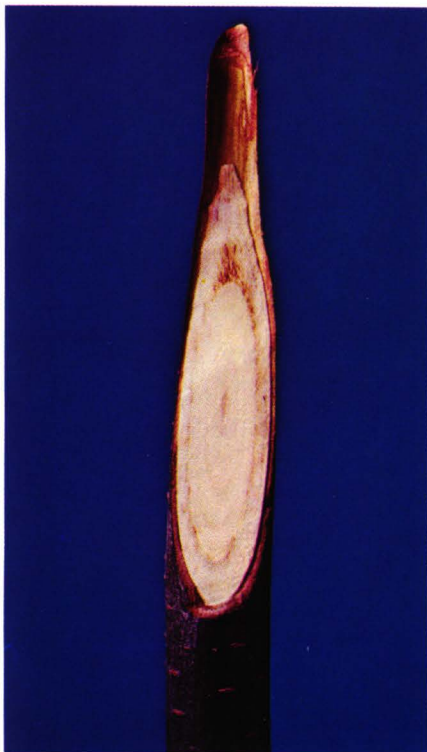
3. Destruction of root grafts will prevent the underground spread of the fungus between diseased and healthy trees.

4. Plant only elms resistant to the Dutch elm disease. Elms resistant to Dutch elm disease have been developed, and the best ones will be released.

Symptoms

Dutch elm disease produces a wilting and yellowing or drying of foliage, usually followed by defoliation and death of the affected branches (cover photo). Trees affected by the Dutch elm disease develop a brown discoloration in the water-conducting vessels of the wood. This may be seen in the outer annual ring by cutting a diseased branch (fig. 2).

Cover.—Symptoms of Dutch elm disease in an American elm. F-521150



F-521152

Figure 2.—Brown discoloration in the wood of infected twig.

The disease symptoms usually appear first on one or several branches and then spread to other portions of the crown. Sometimes, however, the entire tree suddenly develops disease symptoms. Infected trees may die within a few weeks or gradually, branch by branch, over a period of several years. Usually trees that become infected in the spring or early summer die quickly; those that become diseased in late summer may not die until the following year.

Dutch elm disease is one of several vascular wilt diseases attacking elm, all of which produce symptoms that look very much alike. Definite identification of these vascular wilt infections requires laboratory tests using

specimens from the diseased tree. In some instances, the Dutch elm disease fungus may not be found in these tests even though the tree is affected by the disease.

Facilities for making such tests are available at State Agricultural Experiment Stations or State Departments of Agriculture. These tests are rarely needed if Dutch elm disease is known to be well established in your area.

Fungus Carriers

In the United States the principal carriers of the Dutch elm disease fungus are two species of elm bark beetles: the smaller European elm bark beetle, *Scolytus multistriatus* (Marsham) and the native elm bark beetle, *Hylurgopinus rufipes* (Eichhoff). The European species is by far the more common vector in most of the United States and usually displaces the native species.

Like the fungus, the smaller European elm bark beetle (figs. 3, 4, 5) was introduced into the United States from Europe. This beetle was first reported near Boston, Massachusetts, in 1909 and has spread over an even greater area than the disease itself (fig. 1).



F-521153

Figure 3.—Adult smaller European elm bark beetle.

Attacks made by this beetle are for either feeding or breeding. Beetles feed primarily on 2- to 4-year-old twig crotches of living elms (fig. 6). Beetles breed in dying or dead elm wood with intact bark (fig. 7). Healthy elms are readily attacked for feeding, but rarely for breeding purposes. In the summer, complete development from egg to adult takes place in about 6 weeks. Hence, immediate removal of dying elms is important to reduce spread of the disease.

Overwintering larvae complete their development during the spring and emerge from the wood (fig. 8) as adults about the time elms break dormancy. Adults of the smaller European elm bark beetle feed during the entire growing season of the elm.

Because feeding beetles may carry the Dutch elm disease fungus on and in their bodies, they can cause the healthy tree to become infected. The highest disease incidence results from spring and early summer feeding. Spores of the Dutch elm disease fungus introduced into the spring-wood vessels are carried rapidly to other parts of the tree. Vessels produced later in the summer are shorter and smaller in diameter and may restrict movement of the fungus. This may delay the death of the tree.

Beetle emergence begins as early as April and continues through October. Soon after an adult elm bark beetle emerges, it searches for a place to breed. This activity continues throughout the entire growing season of the elm. Tremendous increases in the number of bark beetles can occur in recently killed, cut, or damaged elm trees.

Reservoirs of fungus (fig. 9) may be established in brood galleries. Adult beetles that emerge from these galleries may carry spores and introduce them into healthy elms when they feed. In



F-521154

Figure 4.—Larvae of the smaller European elm bark beetle in feeding galleries in inner bark.

this way the Dutch elm disease fungus may be moved long distances any time during the entire active period of the adult beetle (fig. 10).

Root-graft Spread

Root grafts occur between elms growing near one another. The preva-

lence of root grafts is influenced by the proximity of the trees and soil conditions. The fungus spreads from diseased to healthy trees through these grafts. The extent of spread through root grafts varies, but it is considered to be important, especially where large infected trees are within 35 to 50 feet of healthy ones.

Control

Federal and State research workers have studied Dutch elm disease since 1931. Their goal is to find effective and economical means for preventing or reducing the tremendous losses caused by this disease. At present there are four ways to combat Dutch elm disease:

1. *Reduce the population of beetles* by eliminating elm material required

for breeding. This is a matter of sanitation and tree care.

2. *Protect healthy elms* from feeding beetles. This is done by spraying.

3. *Prevent underground transmission of the fungus* from a diseased tree to adjacent healthy trees. This is accomplished by destroying all grafted roots.



Figure 5.—Pupae of the smaller European elm bark beetle.

F-521155



F-521156

Figure 6.—Scar made by adult smaller European elm bark beetle feeding in a twig crotch. Elms may be infected with Dutch elm disease through these feeding injuries.

4. *Plant trees that are resistant to Dutch elm disease.* Lists of trees suitable for your area are available from your State Agricultural Experiment Station or Cooperative Extension Service.

The heavy loss of elms from Dutch elm disease has created a market for protective and curative treatments.

Many have been tested, but none has proved to be of practical value. In fact, some of these treatments caused serious tree injury. At the present time, no cure for Dutch elm disease is known. Do not invest in Dutch elm disease cures without first investigating their effectiveness through your State Department of Agriculture or State Agricultural Experiment Station.



F-521157

Figure 7.—Brood galleries of the smaller European elm bark beetle on the surface of the wood. The vertical galleries are constructed by the breeding adults and the radiating galleries by the feeding larvae.

Sanitation and Tree Care

Sanitation is important for effective control of Dutch elm disease. Sanitation is most effective when it is begun early, preferably as soon as bark beetles invade an area. **DO NOT WAIT UNTIL THE DISEASE IS PRESENT BEFORE UNDERTAKING A SANITATION PROGRAM.** There are several reasons why sanitation should be practiced:

1. *Sanitation prevents* the rapid increase of bark beetles. An early start in reducing their numbers can delay or reduce the occurrence of diseased trees.

2. *Sanitation reduces* the number of bark beetles and hence increases the effectiveness of sprays.

3. *Sanitation destroys* reservoirs of the Dutch elm disease fungus.

4. *Sanitation eliminates* dead and dying parts that harbor other injurious fungi and insects.

To break the fungus-insect cycle (fig. 10), a four-step sanitation program should be followed:

1. *Destroy all symptomatic elms* found between April and September within 30 days. This will prevent their colonization by beetles that later carry the fungus to healthy elms.

2. *Destroy all elm wood that may serve as breeding sites* for the elm bark beetle. This includes entire elm trees or large branches that have been weakened, recently injured, or killed by drought, storms, or disease.

3. *Carry on sanitation in stands of low-value elms* as conscientiously as in stands of high-value elms.

4. *Systematically search out and destroy bark beetle breeding places.* In addition to standing trees, beetles may lay eggs and produce young in piles of elm logs and in stumps.

Proper disposal of infested elm wood consists of burning it, removing and burning all bark, or burying it in sanitary land fills.

Tree care should be practiced to insure vigorous, healthy trees. Periodic pruning removes wood that may serve as breeding sites for beetles or as entrance courts for organisms that cause diseases. Pruning also eliminates branches that may become subject to breakage in wind or ice storms and thus cause dangerous wounds. However, do not prune elms during the period of beetle emergence.

The application of pesticides, fertilizer, and water are important for maintaining or improving tree vigor.



F-521158

Figure 8.—Smaller European elm bark beetle emergence holes. As many as 2000 adults can emerge from 1 square foot of bark. The usual number is about 400.

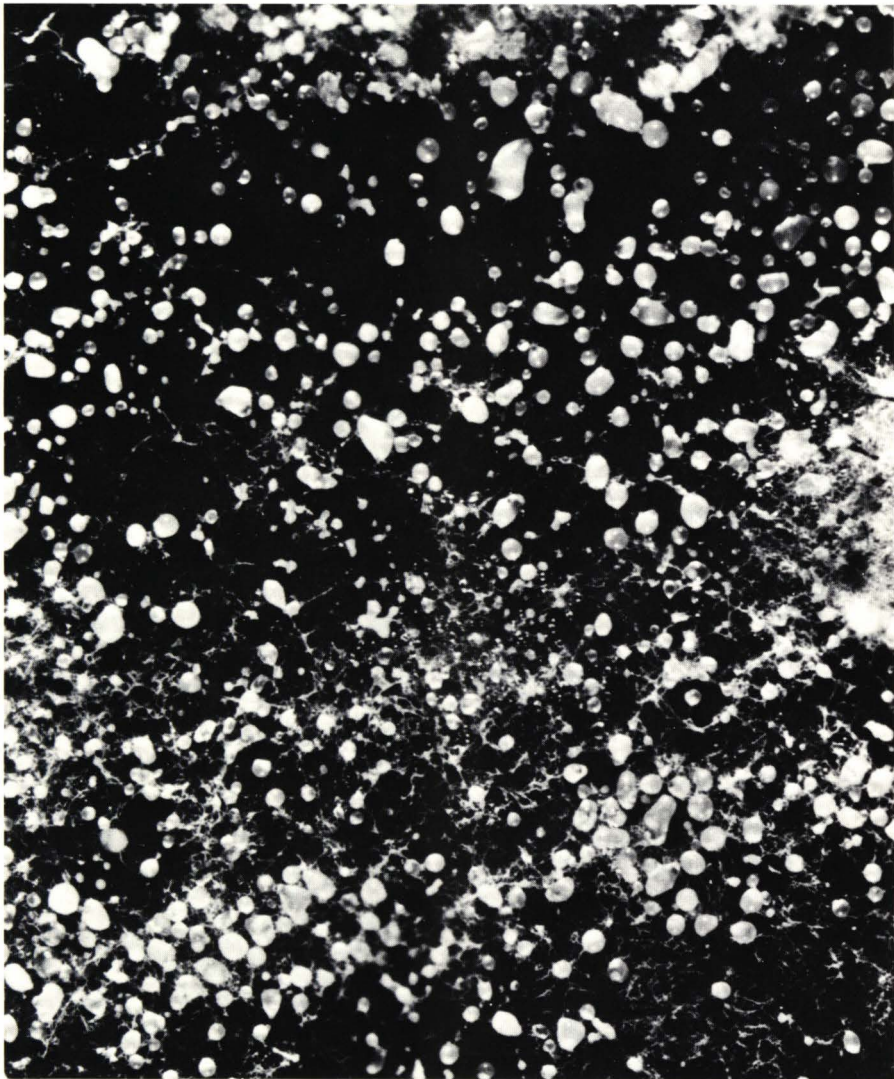
Pesticides may be needed to control insects and diseases that reduce a tree's vigor. Trees growing in good soil in parks and lawn areas may not require frequent fertilizing. However, street trees planted in narrow tree lawns may need more fertilizer and water to retain normal growth and vigor.

Trees should be protected from frequent or severe mechanical injury.

Lawnmower damage may be reduced by removing the sod from around the base of the tree or by constructing tree boxes to reduce mechanical injury to the trunk.

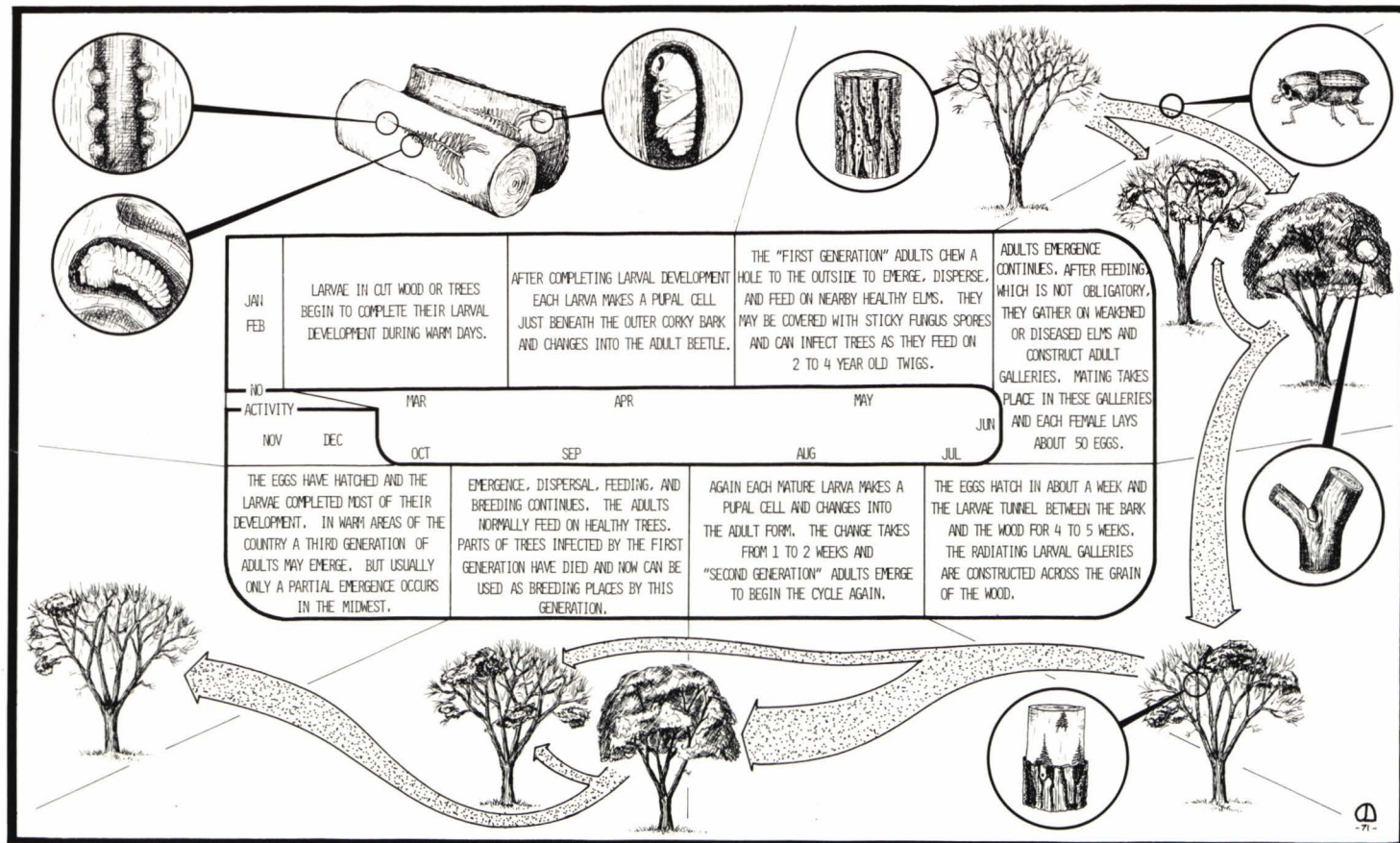
Spraying with Methoxychlor

Research in the control of Dutch elm disease by the U.S. Department of



F-521159

Figure 9.—Spores developing in pupal chamber. Each white glob consists of large numbers of fungus spores in a sticky matrix that clings to the beetle.



11 Figure 10.—The life cycle of the smaller European elm bark beetle. Variations in timing may occur in different geographic locations.

Agriculture and State agencies has resulted in the development of a spray program designed to minimize the loss of elm trees from Dutch elm disease and to reduce environmental pollution.

Spray Equipment and Spray.—Sprays for controlling elm bark beetles may be applied using either hydraulic sprayers or mist blowers. For best results, use hydraulic sprayers having an output of 60 gallons per minute at pressures up to 600 pounds per square inch or mist blowers with an air output of 25,000 cubic feet per minute and a nozzle velocity of 100 miles per hour. Mist blowers should be capable of a spray output of at least one gallon per minute.

The approved rates of methoxychlor for dormant applications are 2 percent* (active ingredient) for hydraulic sprayers and 12½ percent (active ingredient) for mist blowers. Mix 8 gallons of 25 percent methoxychlor EC (emulsifiable concentrate) with water to make 100 gallons of finished spray for hydraulic sprayers. Mix 5 gallons of 25 percent methoxychlor EC with water to make 10 gallons of finished spray for mist blowers. These or similar directions are listed on each methoxychlor container.

When hydraulic spray equipment is used, enough spray should be applied to wet all bark surfaces thoroughly, but run-off should be avoided. This usually requires from 20 to 30 gallons for an average 50-foot elm tree. When mist blowers are used, spray deposits dry so rapidly that no run-off occurs. Between 2 and 3 gallons of spray are needed to adequately treat a 50-foot tree.

How and When to Spray.—All bark surfaces must be completely covered with spray to prevent bark beetle feeding or breeding. *Thoroughness is im-*

portant. Special care should be taken to secure good coverage in the upper part of the tree.

Spray coverage can be greatly improved if two men work as a team. One man sprays while the other observes from a distance to assure complete coverage. Emulsion-type sprays dry very rapidly, and unless it rains within an hour after spraying, there is little loss of deposit from washing.

Elm trees should be sprayed before the smaller European elm bark beetle becomes active in the spring. Spraying should be done on days that have little or no wind, no rain, and temperatures above freezing. Because the residual effectiveness of methoxychlor is not known at this time, dormant applications in the spring are recommended. Fall dormant applications may be effective, but additional research must be completed before they can be recommended. A dormant spring spray will remain effective throughout the period of bark beetle activity. (See pesticide precautions on page 13.)

Control of Root-graft Spread

Root grafts may develop between elms when their roots come in contact. If a tree becomes infected with Dutch elm disease, the fungus may spread to healthy trees through root grafts. Once the disease has become established, a major portion of subsequent tree mortality may result from root-graft spread.

To prevent root-graft transmission, a chemical barrier that destroys the graft must be established between diseased and healthy trees. This may be done by injecting a soil fumigant such as sodium N-methyl-dithiocarbamate vapam into the area of the root graft. For best results, vapam should be applied between the diseased and the next two healthy trees as soon as Dutch elm disease symptoms appear.

* Weight of technical methoxychlor to weight of finished spray solution.



Precautions

Read all the instructions on the manufacturer's label before opening the container.

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

To do this, drill holes 15 to 30 inches deep and 5 to 10 inches apart in a single line midway between diseased and adjacent healthy trees. The holes should extend out well beyond the drip line of the crown. The vapam solution is prepared by mixing one part chemical and four parts water. Pour about 1 cup of the solution into each hole. Seal the hole with soil. To avoid danger, follow the directions on the label.

Planting Resistant Trees

Although elm species vary greatly in their susceptibility to Dutch elm disease, none are immune. Unfortunately, the American elm (*Ulmus americana* L.), our most valuable native elm tree, is one of the most severely affected. The Siberian elm (*U. pumila* L.) and the Chinese elm (*U. parvifolia* Jacq.) are the most disease resistant of the elm species. The genera *Planera* and *Zelkova*, related to the elms, are also resistant.

Despite their susceptibility to Dutch elm disease, elms have many desirable characteristics that make them valu-



F-521223

Figure 11.—The Urban Elm, a disease-resistant tree resulting from a cross between an Asiatic and a European elm.



F-521162

Figure 12.—A selection of Siberian elm with branching habit less subject to breakage in ice and wind storms.

able shade and ornamental trees. They are hardy in a wide range of climatic conditions; many of them have attractive forms and rapid growth rates; and they have been able to adapt well to the rigors of urban environments. For these reasons, the U.S. Department of Agriculture and State Experiment Stations have been conducting research to develop selections of elm that are resistant to Dutch elm disease.

Investigators in the Netherlands have found several elms with a high degree of disease resistance among commonly susceptible European elm

species. One of these, the Christine Buisman elm (a selection of *U. carpinifolia* Gleditsch), has been tested in this country and released for sale. Other more promising selections that are resistant to Dutch elm disease have been developed in this country and abroad. They are being tested for their adaptability to environmental conditions in North America and for their resistance to native pests. One of these, the *Urban Elm* (fig. 11), has been released to the nursery industry for public trial.

The Siberian elm is considered a poor selection as a shade tree in many parts of this country. It is heavily attacked by the elm leaf beetle, and its branch angles make it subject to breakage during ice and wind storms. Yet, it has many features that are desirable. It is resistant to Dutch elm disease, grows rapidly, and is hardy in diverse and rigorous environments

where most other trees cannot survive. Selection and breeding are underway to eliminate the undesirable characteristics in this species. Siberian elms with improved branching have already been selected to minimize limb breakage (fig. 12).

Conclusion

The tremendous loss of elms from Dutch elm disease points up an important lesson to be learned from the extensive planting of a single shade-tree species. The losses due to Dutch elm disease have far outweighed the uniformity and neatness gained by the widespread planting of American elms. By carefully selecting a mixture of species and alternating these from block to block in street-tree plantings, uniform appearance can be retained, and losses due to insects and diseases can be kept to a minimum.

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DUTCH ELM DISEASE CONTROL:

PERFORMANCE and COSTS



William N. Cannon, Jr. and David P. Worley

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DUTCH ELM DISEASE CONTROL: PERFORMANCE AND COSTS

ABSTRACT

Municipal programs to suppress Dutch elm disease have had highly variable results. Performance as measured by tree mortality was unrelated to control strategies. Costs for control programs were 37 to 76 percent less than costs without control programs in the 15-year time-span of the study. Only those municipalities that conducted a high-performance program could be expected to retain 75 percent of their elms for more than 20 to 25 years. Communities that experienced the fewest elm losses had a well founded program, applied it conscientiously and sustained their efforts over the years.



"Nature's noblest vegetable" is what the French botanist André Michaux (1746-1802) called the American elm.

SAVING THE ELMS has been a community goal in many of our cities and towns. Some communities are meeting that goal; some are holding their own; some have failed. In many areas highly-valued American elm trees have been virtually eliminated by Dutch elm disease. The methods of disease control have been aimed at blocking the transmission of the fungus to healthy elms by elm bark beetles and through root grafts between diseased and healthy elms.

To find out how well Dutch elm disease control programs are working, we gathered and analyzed public records of control performance and costs for 39 municipalities, many of them in the Midwest, where Dutch elm disease is less likely to be confounded by elm losses due to phloem necrosis. The municipalities studied ranged in population from 3,000 to 1,500,000 and had elm trees ranging in numbers from 2,000 to 50,000.

The records available ranged in time span from 5 years to 18 years. The information reported was: (1) the total number of elm trees in the city or in the control program, (2) the number of elms contracting Dutch elm disease each year, (3) the control measures specified, and (4) the costs of the control program.

Additional data were taken from published sources (*Neely 1967 and 1972, and Neely and others 1960*).

We combined all these records and other information to find out how well the control measures were keeping the Dutch elm disease within manageable proportions. Community performance in Dutch elm disease control was judged by how successful the

community was in saving its elms, and the financial consequences of the control program.

Control Strategies

Control measures can be classified on a technological basis into three major strategies:

Strategy

1. Reduce bark beetle habitat.
2. Reduce bark beetle habitat and control beetle population.
3. Reduce bark beetle habitat, control beetle population, and prevent transmission through root grafts.

Vector control measures

- Sanitation (prompt removal of infested elms and pruning of infested branches).
- Sanitation and use of insecticide to further reduce beetle population and reduce transmission of the disease.
- Sanitation, use of insecticide, and injection of chemicals into soil to prevent transmission through root grafts.

Even though they are technically logical, these strategies cannot be used as a basis for rating performance. We first combined data from different municipalities according to these strategies, expecting to find that those municipalities that had followed strategy 3 got better performance than those that followed strategies 1 or 2. Performance data were measured in number of trees becoming infected each year per 1,000 original elms.

Contrary to our expectations, we found that there was no correlation between performance and strategy. A municipality that sustained a particular level of performance

under one strategy (strategy 2) performed similarly when it switched strategies (to strategy 1 or strategy 3). These technological strategies are mere labels, and we question if such labels are relevant to control performance. Good performers (municipalities with a low incidence of Dutch elm disease) did a better job whatever strategy they followed, if the strategy was appropriate to their local situation — that is, tree spacing, disease incidence, factors affecting the beetles, etc.

Control Performance

We grouped municipalities into classes based on sustained control performance. We labeled these:

1. Best performance — those municipalities that have an elm mortality of about 1 percent of the original elms per year.
2. Good performance — those municipalities that had a mortality rate of no more than 3.5 percent per year.

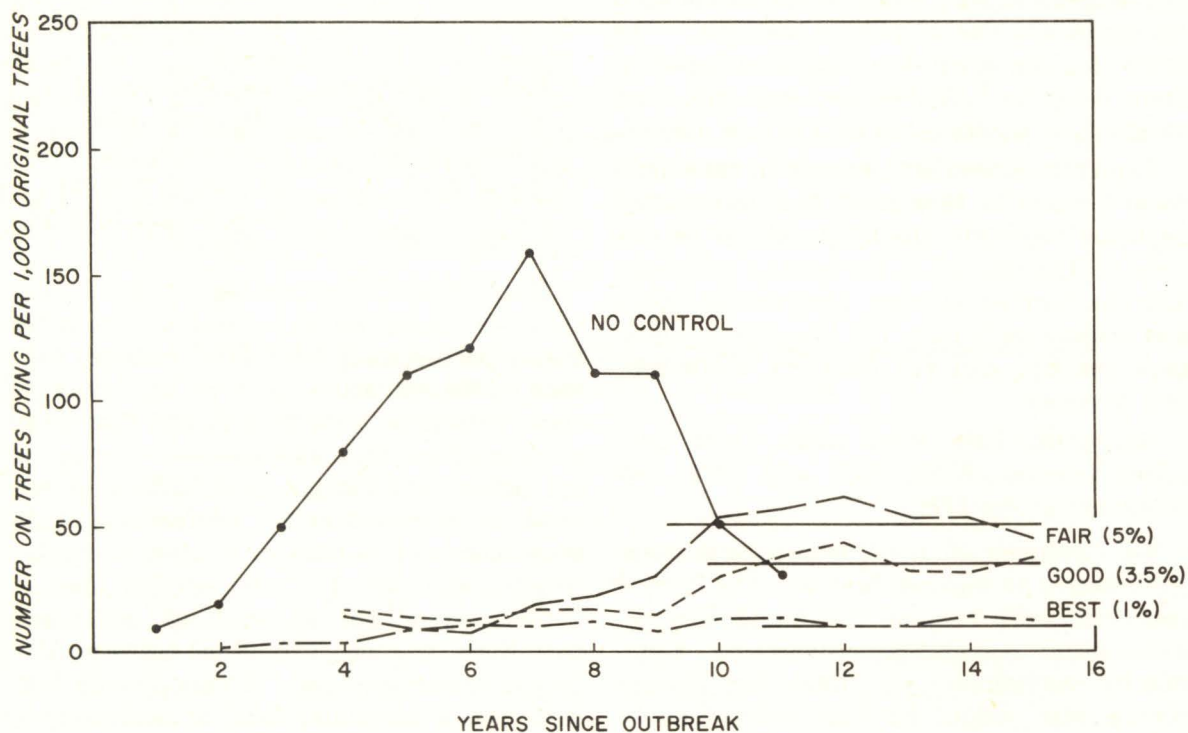
3. Fair performance — those municipalities that had a mortality rate of no more than 5 percent per year.
4. No control.

The records of these groups of municipalities were contrasted with those that had no control programs (fig. 1).

To understand the reasons for differences in control performance, we talked to researchers and others in the control business, we read many accounts of how Dutch elm disease progressed in different cities, and we devised a list of reasons for the differences in performance.

Biological reasons.—1. Different spacing of elms call for different control measures. For example, a municipality in which elms are closely clumped together couldn't attain a high performance without root-graft control, whereas a municipality in which elms are widely distributed wouldn't need it. 2. Different physical distributions of elms alter the probability of their contracting the dis-

Figure 1.—Number of trees expected to die each year under each of four control-program performance levels.



ease. For example, elms could be so widely dispersed and such a small part of the total shade-tree population that transmission of the disease by root grafts would be minimal.

Operational reasons.—1. Lack of leadership in the community and failure to understand the gravity of the situation (*Gundersen 1964*). 2. Lack of money. 3. A mixture of authorities, each of which is responsible for a certain group of elms, all operating within different priorities or budget constraints so that their work is inconsistent with a total control program. 4. Group conflicts within the community government or among influential organizations. 5. Lack of effective authority to treat or remove privately owned elms, so that islands of disease elms are left for prolonged periods. 6. Crews in the field who do not conduct their work carefully and conscientiously, and a management that does not allow enough time to do a good job.

Of course, not all of these factors are present in any one municipality, and there could be other ones that are paramount in particular communities. One factor that seems to be of concern in most communities is the privately-owned diseased elm and the community's lack of authority to remove it promptly.

If a community is to have an effective disease-control program, it must plan and study carefully to make sure that it develops a program based on biological conditions. And no matter how good a program is, it will not succeed unless it is carried out

vigorously and conscientiously under a unified authority that has the power to compel action.

Control Costs

Different municipalities account for costs differently. We could not relate performance data to cost of control programs. To do so would have required on-site cost studies. The information we brought together was not suitable for a rigorous breakdown of performance against cost. In fact, both good performers and poor performers had a similar range of costs for individual jobs and for the total control program. Some excellent performances seemed very economical while some poor performances seemed very expensive. The costs we did collect are given in table 1.

Save-the-elms Evaluation

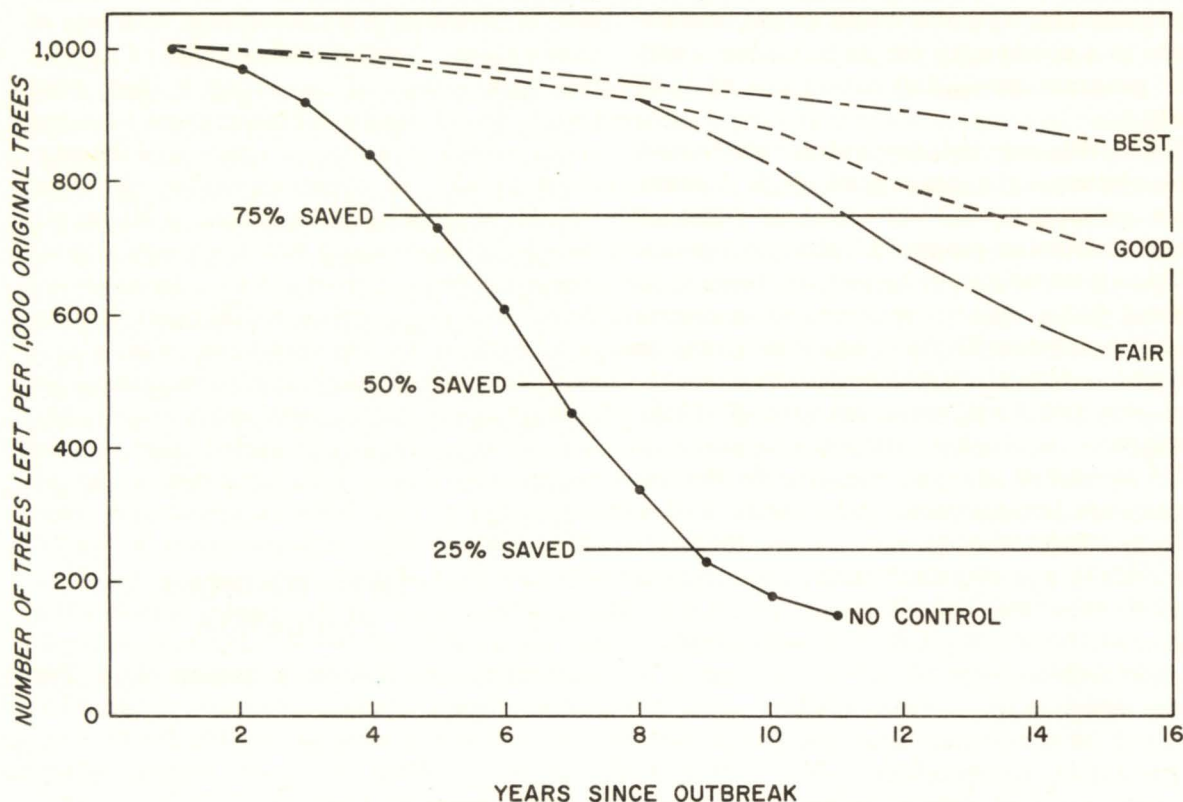
Most communities engaging in a Dutch elm disease control program would like to save as many elms as possible for as long as possible. What do these control performances mean in terms of *save-the-elms*?

For example, we might select 75 percent saved as a goal. All but the best performance level will allow the elm population to fall below this goal in the 15-year time frame of the study (fig. 2). Without any control, the population of elm trees would drop to the 75-percent level in about 5 years. With the fair and good levels, it would take 11 and 13 years respectively. But with the best

Table 1.—1972 costs of individual jobs comprising the municipal Dutch elm disease control program

Job	Units	Cost	
		Range	Average
Tree removal	Per tree removed	\$60.00-250.00	\$125.00
Sanitation	Per tree in population	1.00- 2.00	1.50
	Per tree sanitized	15.00- 40.00	25.00
Spraying	Per tree in population	0.50- 0.70	0.60
	Per tree sprayed	1.50- 2.75	2.00
Root-graft control	Per tree treated		5.00
Survey for symptoms	Per tree in population	0.15- 0.30	0.20

Figure 2.—Length of time in which save-the-elms goals can be achieved with different control-program performance levels.



control, it would take 25 to 27 years to drop the population to the 75 percent level.

Of course, if we were willing to use a goal of 50 percent saved, our time frames would be greatly expanded (table 2).

Table 2.—Years before the elm population is reduced to various percentages of the original number of elms by following any one of four municipal performances

Performance class	Years to reduce elm populations to designated levels of the original elms ^a	
	75% Level	50% Level
No control	5	7
Fair control	11	(16-18)
Good control	13	(20-22)
Best control	(25-27)	(44-48)

^aEstimates in parentheses are extrapolated, assuming continuation of the recorded trends.

Financial Consequences

Most municipalities operate on a budget basis rather than on an investment basis. In our financial evaluation, we did not use a discount rate to conform to budgets. We used our cost data (table 1) and our performances data (fig. 1) to develop a 15-year budget for three alternative courses of action.

1. Tree removal with no control, an estimate of the cost of doing nothing.
2. Tree removal with fair control, using the higher costs from the cost range (table 1). This gives us an estimate of the highest average costs to be expected from an active control program.
3. Tree removal with the best control performance, using the lowest costs from the cost range. This gives us an estimate of the lowest average costs to be expected from an active control program.

The costs of active control measures were used to produce a band of costs rather than cost lines (fig. 3). We would expect that the costs to a community for undertaking a control program would fall inside this band of costs.

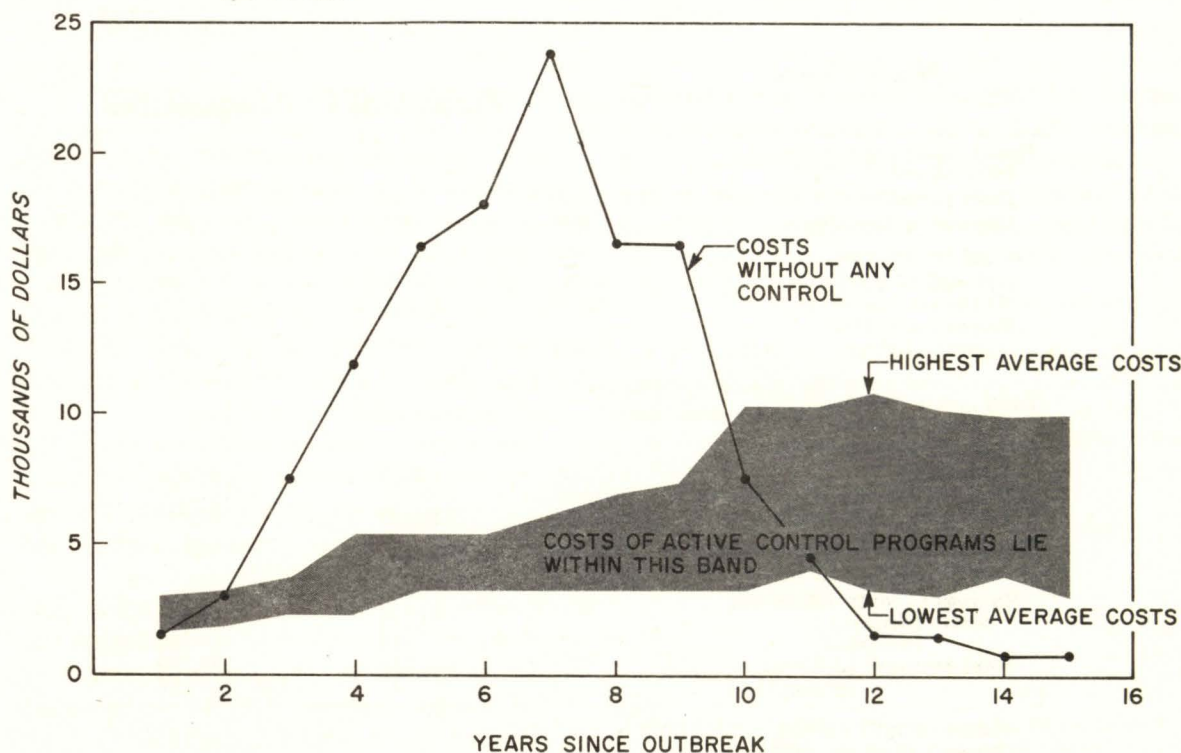
The costs of the no-control alternative rise spectacularly, peaking at about 7 years, then declining to well below the cost band for active control measures at about 12 years. At that time only 10 to 15 percent of the elms remain alive. Early active control efforts slow the increase in costs; and finally, in 5 to 10 years—depending on the efficiency of control—the costs will settle into fairly steady patterns. In 15 years we will still have 55 to 85 percent of the elms left alive, depending on control performance. The benefits of a control program are:

1. More time to enjoy our elms.
2. Fewer budget fluctuations.
3. Time for scientists to find better control measures.

By far the largest loss to the community where control is not undertaken is the reduction of property value associated with loss of shade trees. The minimum value of an elm tree is the cost of removing it, but most people would assign a higher value to it for such esthetic reasons as shade and beauty. Hart (1965), in a report on the economic impact of Dutch elm disease in Michigan, stated that the loss in esthetic value greatly overshadowed all other losses. In addition, there are losses of urban wildlife and changes in microclimates. In view of the difficulty in assigning a dollar value to these losses, we chose to use property-value losses since Payne and others (1973) suggested that shade, microclimatic, and esthetic benefits can be considered as they relate to residential property values. They indicated that a loss of \$250 per tree was appropriate.

Summary costs and average annual costs for the 15-year period are given in table 3. Tree mortality was multiplied by \$250 per

Figure 3.—Tree removal and control costs, based on a unit of 1,000 trees.



tree to estimate property loss. For the no-control alternatives, annual budget requirements for the peak year are 2.7 times the average budget requirements. Where positive control measures are taken, the peak budget requirements amount to 1.2 to 1.6 times the average.

Total loss during the 15-year period (table 3) includes the cost of control (table 1), disposal of dead and dying trees, and property value loss. If effort is made to remove elms before they become physical hazards, the budget requirements of a do-nothing program can exceed those of a control program, especially during the 12-year period after introduction of the disease. Larger losses of elms each year require greater personnel and equipment to deal with the situation. A recent development to reduce the costs of tree removal and disposal, and also reduce the volume of material going into sanitary landfills, is to sell the wood for lumber, pulpwood, and other useful products.

While we didn't consider replanting values

in our costs, a tree-replanting program could lessen the impact of elm losses on property values in future years. One can hardly equate the esthetic and shade value of newly planted trees 2 to 3 inches in diameter with that of elms 20 to 30 inches or more in diameter, but replacement would eventually assure a stable tree population that would benefit the community.

We judged the effectiveness of the control program in terms of the budget figures and in terms of community values, which include property-value loss. The highest and lowest costs were subtracted from the no-control totals and expressed as savings in dollars and as a percentage of the no-control costs (table 3). The budget savings in control and disposal costs alone amounted to between \$20,000 and \$80,000 for our 1,000-tree unit or between 16 and 63 percent of the no-control option.

These savings were calculated at a zero discount rate as being relevant to a budget situation rather than an investment situa-

Table 3.—Economic impact of control measures for a 15-year period

Items of concern	Cost and performance for three alternatives, based on a 1,000-tree unit ^a		
	No control	Low performance: high cost control	High performance: low cost control
Status of elm population after 15 years:			
Dead (number)	880	438	133
Remaining (number)	120	562	867
Annual budget cost:			
Average (dollars)	8,800	7,400	3,300
Maximum (dollars)	24,000	11,900	4,050
Maximum increase above average: (dollars)	15,200	4,500	650
(percent)	173	60	20
Total loss + cost during the 15-year period:			
Cost of control and disposal (dollars)	132,000	111,290	49,030
Property value loss ^b (dollars)	220,000	109,500	34,250
Total cost + loss (dollars)	352,000	220,790	83,280
Effectiveness of control operation over the 15-year period:			
Savings in control disposal costs: (dollars)		20,710	82,970
(percent)		16	63
Total savings: (dollars)		131,210	268,720
(percent)		37	76

^aBased on 1972 dollars.

^bPayne and others (1973).

tion. Had we calculated them with a positive discount rate, say 5 percent, the percentage savings would have been larger. The peak costs of the no-control option against which the active controls were compared would have been disproportionately greater. Our percentage savings on a budget basis are conservative.

Both Marsden (1953) and Sinclair and others (1968) proposed that the annual expenses of a control program might be substantially less than the expense of elm removals in the absence of a program. The experiences of the municipalities in our study bear this out (fig. 3). Of course, the annual cost of elm removals in a no-control program will decline as fewer and fewer elms remain to be infected with the disease. The additional cost of an active control program will, at that time, be protecting a substantial elm population (table 3).

The implication for managers in terms of budget requirements is that even the costliest control program would create less of an impact on the annual budget than the tree-removal costs of no control (fig. 3). If the disease were allowed to proceed unchecked, the annual budget requirements would rise sharply. This would probably disrupt the budget planning of most communities.

Summary and Discussion

The efforts made by municipalities to suppress Dutch elm disease have had highly variable results. Differences in performance could be traced to both biological and operational reasons. In many instances the operational difficulties outweighed the biological factors. We found that performance was not related to particular control strategies.

The budget costs of control programs were less than the costs of removing the large numbers of elms associated with the no-control alternative. Fluctuations in the annual budget were minimized, enabling managers to plan for the long pull and to maintain control performance. Total savings attributed

to control programs ranged from 37 to 76 percent.

A community attempt to save the elms is greatly enhanced by an active control program. If we assume that a reasonable goal is to save 75 percent of the elms, the lack of an active control program will allow the elm population to sink below the goal in 5 years. An active program can extend this time by a factor of 3 to 5, depending on the level of control performance.

The quality and quantity of effort to apply control programs to limit Dutch elm disease inevitably reflects the interests and resources of local communities and their governing bodies. Some communities temporarily suspended control programs during a period of temporary financial stress only to find that they could not regain control of the disease situation later. Faced with increasing elm losses, and lacking the resources to substantially increase their control efforts, they found themselves with an ever worsening situation until few elms remained. The communities that experienced the fewest elm losses not only had well-founded control programs and applied them conscientiously, but sustained their efforts over the years.

Literature Cited

- Gunderson, H.
1964. ATTITUDES TOWARD AND SUCCESSES OF DUTCH ELM DISEASE CONTROL PROGRAMS. Entomol. Soc. Am. North Cent. Branch Proc. 19:29.
- Hart, J. H.
1965. ECONOMIC IMPACT OF DUTCH ELM DISEASE IN MICHIGAN. Plant Dis. Rep. 49:830-832.
- Marsden, D. H.
1953. DUTCH ELM DISEASE: AN EVALUATION OF PRACTICAL CONTROL EFFORTS. Plant Dis. Rep. 37:3-6.
- Neely, D.
1967. DUTCH ELM DISEASE IN ILLINOIS CITIES. Plant Dis. Rep. 51:511-514.
- Neely, D.
1972. MUNICIPAL CONTROL OF DUTCH ELM DISEASE IN ILLINOIS CITIES. Plant Dis. Rep. 56:460-462.
- Neely, D., J. C. Carter, and R. J. Campana.
1960. THE STATUS OF DUTCH ELM DISEASE IN ILLINOIS. Plant Dis. Rep. 44:163-166.
- Payne, B. R., W. B. White, R. E. McCay, and R. R. McNichols.
1973. ECONOMIC ANALYSIS OF THE GYPSY MOTH PROBLEM IN THE NORTHEAST. II. APPLIED TO RESIDENTIAL PROPERTY. USDA For. Serv. Res. Pap. NE-285. 6 p.
- Sinclair, W. A., W. T. Johnson, and J. A. Weidhaas.
1968. MUNICIPAL DECISIONS ON DUTCH ELM DISEASE CONTROL. N. Y. State Coll. Agric. Cornell Tree Pest Leaflet A-4. 8 p.

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